FLUKE®

Programmable Power Supplies

PM2811 - PM2812 - PM2813 - PM2831 - PM2832

Reference Manual

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FLUKE®

PM2811-PM2812-PM2813
PM2831-PM2832

Programmable Power Supplies

Reference Manual

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INSIDE THIS MANUAL

HOW TO USE THIS MANUAL

This reference manual has been aimed at the experienced user as well as the user new to Programmable Power Supplies. It will help the reader to operate the power supply manually (local operation) or from a PC via the General Purpose Interface Bus (remote operation).

This manual contains the following information

Chapter 1 OPERATING INSTRUCTIONS
Gives full reference information about operating your power supply in the following modes:
1) locally (via the keys and the display)
2) remotely (via programming commands and queries)

Chapter 2 MAINTENANCE INSTRUCTIONS
Gives information about how to maintain your power supply, covering preventive measures as well as corrective measures.

Appendix A TECHNICAL SPECIFICATIONS
Gives performance specifications about your programmable power supply.

Appendix B PERFORMANCE VERIFICATION PROCEDURE
Describes how to conduct a performance verification test for your programmable power supply.

Appendix C CALIBRATION PROCEDURES
Describes how to calibrate your power supply manually using the keys or remotely via a GPIB controller.

Appendix D ERROR MESSAGES
Gives a summary and explanation of the error messages.

INDEX This is an alphabetical list of all remote commands and Queries.

Declaration of Conformity

for

PM2811, PM2812, PM2813, PM2831, and PM2832
Programmable Power Supply

Manufacturer

Fluke Industrial B.V.
Lelyweg 1
7602 EA Almelo
The Netherlands

Statement of Conformity

Based on test results using appropriate standards,
the product is in conformity with
Electromagnetic Compatibility Directive 89/336/EEC
Low Voltage Directive 73/23/EEC

Sample tests

Standards used:
EN 61010-1 (1993)
Safety Requirements for Electrical Equipment for
Measurement, Control, and Laboratory Use

EN 50081-1 (1992)
Electromagnetic Compatibility.
Generic Emission Standard:
EN55022 and EN60555-2

EN 50082-1 (1992)
Electromagnetic Compatibility.
Generic Immunity Standard:
IEC801-2, -3, -4, -5

The tests have been performed in a typical configuration.

This Conformity is indicated by the symbol CE,
i.e. "Conformité européenne".

1 OPERATING INSTRUCTIONS

1.1 INTRODUCTION

This chapter contains all the details about how to operate your programmable power supply. There are two main sections in this chapter:
Section 1.2: Operating locally using the keys and the display.
Section 1.3: Programming remotely via a GPIB controller (commands/queries).

1.2 LOCAL OPERATING INSTRUCTIONS

The keys described in this chapter appear in the same order as they are numbered on the next page. Following pages give a functional description of each individual key. Each key description starts on a new page and consists of the following:

- Key legend Illustrates the key.
- Action: Describes the function of the key.
- Display: Shows the response on the display.
- Description: Provides additional information.
- Example: Gives sample use.
- Errors: Lists error conditions and error messages.

Notes:
- *In general you can assume that an operating function that is started by pressing a function key can be terminated by pressing the ENTER key or another function key.*
- *For a single output model, the displayed indication n will be a space.*
- *For a multiple output model, the displayed indication n is the output channel selected.*
- *For most of the reference descriptions it is assumed that the power supply is in the OPERATE mode.*
- *A key is active only in the LOCAL mode, except for the LCL key.*

1.2.1 Key references

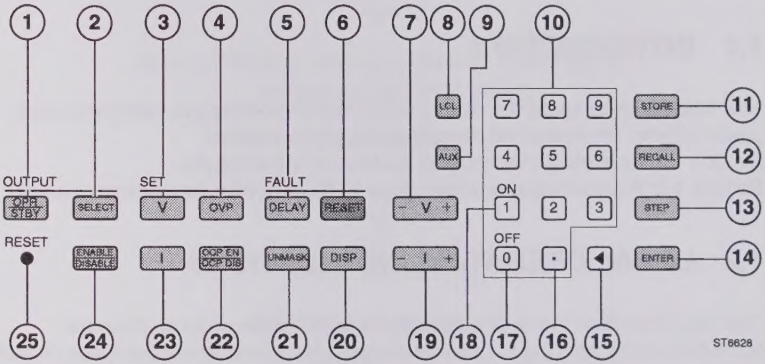


Figure 1.1 Front panel

Note: Keys 2 and 24 are not available on PM2811 and PM2831

(1)

Action: Controls all output channels of the power supply at the same time. All output channels will go into the OPERATE mode or into the STANDBY mode.

Display: In the STANDBY mode with output channel n selected:

```
n              S T A N D B Y
```

In the OPERATE mode with output channel n enabled and selected:

```
n    d d . d d V   d d . d d A
```

In the OPERATE mode with output channel n disabled and selected:

```
n  D I S A B L E D
```

Description:

If an individual output was disabled, it will remain disabled when your power supply goes into the OPERATE mode. When your power supply is in the STANDBY mode, its output will behave as it if was programmed to zero volts and zero amperes.

By switching from the OPERATE mode to the STANDBY mode the protection of all output channels is reset. The fault register(s) will not be cleared.

Example:

Press [SELECT] to select output 1 (for multiple output models only)

Press [ENABLE DISABLE] to enable output 1 (for multiple output models only)

Press [OPR STBY] to enter the OPERATE mode.

PM2811 PM2831

Action: Selects the next output channel.

Display: The number of the selected output channel is shown on the display as the leftmost character. For a single output model, the output channel number is not displayed.

Description:

This key is applicable only for multiple output channel models. The selection of the output channels is in a forward and cyclic sequence when pressing the SELECT key sequentially, i.e., output 1 first, then output 2, and output 1 again.

Example:

This key is useful for verifying the settings of all output channels. It is also useful for examining the operating status of all output channels, i.e., to check which annunciators are displayed.

Action: Verifies or sets the output voltage of the selected output channel. The voltage can be set when this key is used with the numerical input keys.
In step mode the active voltage is shown when pressing this key.

Display: n V S E T d d . d d V

Description:

Your power supply will round off the entered voltage setting V_{set} to the nearest multiple of the resolution of the selected output channel (see the specifications in Appendix A).

If a value outside the valid range is entered, it will be ignored, and the display will show: V S E T M A X = d d V
Where dd is the maximum voltage.

This function is active in the STANDBY mode as well as in the OPERATE mode. Press the SELECT key to select one of the output channels (n).

When the V key is used in the step mode, the actual output voltage is displayed (in the OPERATE mode) or the voltage setting (in the STANDBY mode).

Example:

Press [V]
The display will show: n V S E T d d . d d V
Press [2] [•] [3] [4]
The display will show: n V S E T 2 . 3 4 V
Press [ENTER] to enter the programmed output voltage.
If the output channel is in OPERATE mode and in CV mode, the display will show: n 2 . 3 4 V d d . d d A

Action: Verifies or sets the overvoltage trip level of the selected output channel. The overvoltage trip level can be set with the numerical input keys.

Display: n O V S E T d d . d d V

Description:

Your power supply will round off the entered overvoltage level OVset, set to the nearest multiple of the resolution of the selected output channel (see the specifications in Appendix A).

The programmable overvoltage protection guards the load against excessive voltages. If the overvoltage level is exceeded, the output channel will be shut down, i.e., the output reduced to zero volts and zero amperes. The message OVERVOLTAGE will also be displayed. If a value outside the valid range is input, it will not be accepted and the display will show:

O V S E T M A X = d d V

Where dd is the maximum overvoltage level.

Recovery from this fault situation can be accomplished by removing the cause of the overvoltage protection tripping and by pressing the RESET key.
Press the SELECT key to select one of the output channels.
When COUPLED PROTECTION is on, the output channel may also be shut down if another coupled output channel is shut down because of any protection tripping.

Example:

There is an overvoltage situation that must be reset. The output voltage setting = 8 V. Therefore, proceed by setting the overvoltage trip level higher than the programmed voltage setting:

- Press [OVP] [1] [0] [ENTER]
- Press [OVP] and check the overvoltage setting.
- The display will show: n O V S E T 1 0 . 0 0 V
- Press [ENTER]. The overvoltage level remains at 10 V.
- Press [RESET] to reset the overvoltage situation.

Errors:

If the programmed value is higher than the maximum allowed value, the following is displayed: O V S E T M A X = n n V
If the programmed value is lower than the minimum allowed value, the following is displayed: O V S E T M I N = n V
If another coupled output channel has been shut down and the DEN bit has been unmasked, the following is displayed only once after a reset:
n F A U L T O U T P U T m

DELAY (5)

Action: Verifies or changes the reprogramming delay time in units of 1 ms from 0 to 60.00 seconds.

Display: n D E L A Y 0 . 0 1 s
The display shows the actual setting, which can be changed by pressing the numeric entry keys, then pressing the ENTER key.

Description:

When the setting of an output channel is altered or after a protection reset, your power supply may change modes momentarily. To prevent the reporting of faults during this momentary switching, a delay can be programmed. This reprogramming delay specifies the time period in which the CV, CC, and UNR bits in the status register will be masked from being reported in the fault register and from activating the overcurrent protection circuit. If a value outside the valid range is input, it will not be accepted and the display will show:

D E L A Y M A X = 6 0 s

The reprogramming delay is active when a function is executed that is activated by the following keys:

V | I | − V + | − I + | RECALL | STEP | RESET | OPR STBY | ENABLE DISABLE

Example:

The power supply must be in the local mode, i.e., the text REM may not be displayed.

Press DELAY
The display will show: n D E L A Y d d . d d s
Press 1 •
The display will show: n D E L A Y 1 . s
Press 2 3
The display will show: n D E L A Y 1 . 2 3 s
Press ENTER to enter the reprogramming delay of 1.23 seconds.

Action: Resets the selected output channel to its programmed operating mode.

Description:

The following protection features will be reset in the OPERATE mode:

- overvoltage
- overcurrent
- overtemperature
- out of the sense capability

Before any protection can be reset, the condition(s) that activated the protection must be removed, e.g.:

- In the case of an overvoltage or overcurrent situation, the load conditions must be changed or the output settings must be adjusted.
- In the case of overtemperature, the internal reference temperature has to become lower than the specified release temperature of 60°C ± 5x°C.
- if the sense capability is exceeded the load lead resistance must be lowered.

Note: A fault indication in the status register will not be reset by pressing the RESET key. Reset of a fault indication will occur only after the fault register has been read.

Example:

There is an overvoltage situation, which must be reset. Proceed by setting the overvoltage trip level 20 % higher than the programmed voltage of 5 V:

- Press [OVP] [6]
- The display will show: n `OVSET 6.00V`
- Press [ENTER] to enter the overvoltage trip level.
- Press [RESET] to reset the overvoltage protection circuit.

Action: Adjusts the output voltage setting.

Display: The actual output voltage and current will be displayed if the power supply is in the OPERATE mode.

Description:

The output voltage setting will be decreased when you press the left part (– V), and will be increased when you press the right part (V +). The change in voltage setting depends on the programming resolution (see the specifications in Appendix A).
The change of the output voltage can be monitored on the display if the power supply is in the constant voltage (CV) mode. This key is active only in the OPERATE mode.

Note: Keeping the left or the right part of the key depressed will cause the output voltage setting to automatically decrease or increase at a rate of 4 times per second after $^1/_2$ second with its LSD value, and after 3 seconds with 10 times its LSD value (LSD = least significant digit).

Increasing the output voltage setting is possible until one of the following conditions occurs:

- The maximum setting of the output voltage is reached.
- The maximum setting of the output power (Iset x Vset) is reached. In this case there are two possibilities, i.e.:
  - COUPLED_PARAMETERS = ON:
    The power supply will adjust the current setting Iset along the constant power characteristic until the maximum setting of the output power is reached. Every time the current setting is adjusted, the CP bit in the status register is set.
  - COUPLED_PARAMETERS = OFF:
    The power supply will not adjust the settings. The output voltage increase will stop at its maximum possible value.

If the constant voltage (CV) mode is entered, the annunciator above the text CV is displayed.

Note: If [– V +] is pressed while the voltage is not displayed, the adjustment of the output voltage setting goes on.

Example:

For this example your power supply must be in the OPERATE mode and in the Constant Voltage mode, i.e., the annunciator above the text CV should be displayed.

The display will show, e.g.: n a a . a a V d d . d d A

Press the right part of the – **V** + key 6 times.

The display will show, e.g.: n b b . b b V d d . d d A

For a 60V/1A output channel, the value of bb.bb should be approximately 6 x 0.015 = 0.09 volt higher than aa.aa.

Action: Obtains local control of the power supply.

Display: The text REM will no longer be displayed.

Description:

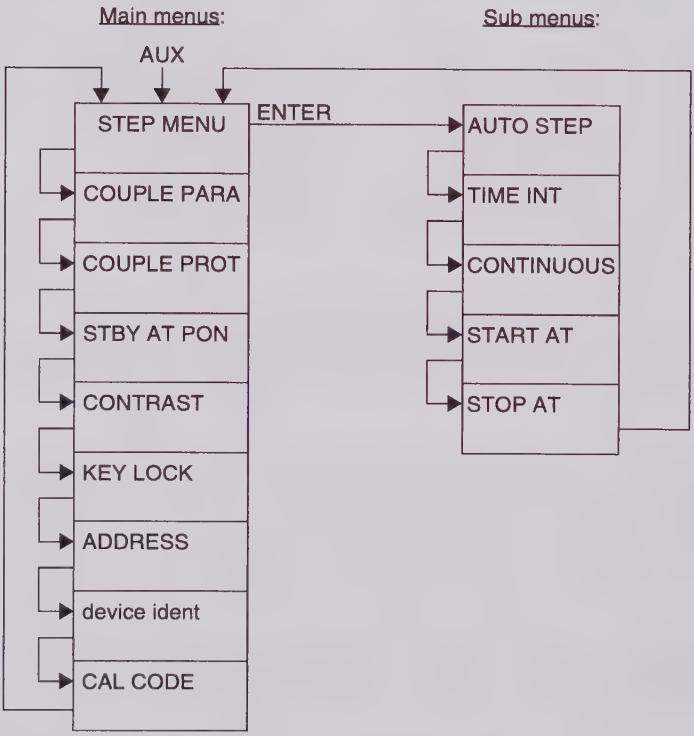
When the keyboard was locked in the remote state, it will automatically be unlocked again if the LCL key is pressed.

The display will be turned on if it was turned off during remote operation.

Local control cannot be obtained if your power supply has been programmed in the 'local lockout' state with the GPIB command LLO.

AUX 9

Action: Executes auxiliary interface and control functions. Those functions are presented in a main menu/submenu structure. Each time the AUX key is pressed, the next main menu or next submenu function is controlled. The first STEP submenu function is entered by pressing the ENTER key.



Note: The menu structure is exited when the ENTER key is pressed instead of the AUX key. The menu structure is not exited when a numeric key is pressed before the ENTER key is pressed.

STEP	FUNCTION	FRONT PANEL KEYS TO BE USED
1	STEP MENU	ENTER (goto 1a) AUX (goto 2)
a	• AUTO STEP	ON, OFF
b	• step TIME INTerval	0 to 9, ENTER
c	• CONTINUOUS step	ON, OFF
d	• sequence START AT	0 to 9, ENTER
e	• sequence STOP AT	0 to 9, ENTER
2	COUPLE PARAmeters	ON, OFF
3	COUPLE PROTection	ON, OFF
4	STandBY AT Power ON	ON, OFF
5	display CONTRAST	0 to 9, ENTER
6	KEYboard LOCK	ON, ENTER
7	GPIB interface ADDRESS	0 to 9, ENTER
8	device identification	SELECT
9	CALibration access CODE	0 to 9, ENTER

Note: ON is the 1 key, and OFF is the 0 key.

Display: The following functional text will be displayed: (with default values)

```
1  :    S T E P   M E N U
1a :    A U T O   S T E P          O F F
1b :    T I M E   I N T          O . 1 s
1c :    C O N T I N U O U S        O F F
1d :    S T A R T   A T              1
1e :    S T O P   A T              9 9
2  :    C O U P L B   P A R A      O F F
3  :    C O U P L E   P R O T      O F F
4  :    S T B Y   A T   P O N      O N
5  :    C O N T R A S T              8
6  :    K E Y   L O C K            O F F
7  :    A D D R E S S              2 8
8  :    P M 2 8 x x   V y . y   N : z z
```

Notes: xx are the last digits of the type number.
y.y is the version of the processor software.
zz is the software version of output channel N.

```
9  :    C A L   C O D E
```

Description:

The sequence of functions in the menu is fixed. The subsequent data for each function can be verified or changed without leaving the menu. This makes it possible to view and change all the functions in one session. The sequence of functions after pressing the AUX key is as follows:

1: STEP MENU

This function consists of five subfunctions to define the STEP function. Press the ENTER key to enter the first submenu function. Press the AUX key to enter the next main menu.

1a AUTO STEP

The auto-step function can be set on or off, using the ON(1) or OFF(0) key. If auto-step is on, the AUTO_STEP function is executed as soon as the power supply enters the OPERATE mode. If the AUTO_STEP function is executed, it is not possible to step manually by using the STEP key. The AUTO_STEP function can be exited by setting the AUTO_STEP to OFF or by pressing the ← (backspace) key. During the execution of the AUTO_STEP function, the annunciator above the text STEP on the front panel is displayed.

1b TIME INT

The step interval time can be set. Ranges of the setting are as follows:
PM2811/12/13: from 0.1 to 60.0 seconds in steps of 0.1 second.
PM2831/32: from 25 ms to 60.0 seconds in steps of 1 ms.
If auto-step is on and the OPERATE mode is entered, the AUTO_STEP function is not executed in the STANDBY mode.

1c CONTINUOUS

The continuous step function can be set on or off, using the ON(1) or OFF(0) key. If continuous step is on, the preprogrammed STEP sequence is executed continuously. If continuous step is off, one preprogrammed STEP sequence is executed, starting with the start step address and stopping at the stop step address.

1d START AT

The start address of the step sequence can be set. The range of the setting is from 1 to 999. The start address indicates the beginning of the sequence.

1e STOP AT

The stop address of the step sequence can be set. The range of the setting is from 1 to 999. The stop address indicates the end of the sequence.

Note: The stop address (e.g., 20) may be smaller than the start address (e.g., 50). If this is the case, the sequence will be 50, 51 to 998, 999, 1, 2 to 19, 20.

2: COUPLE PARA (Not applicable for the linear power supplies).
This function allows the coupling between the programmed voltage and current setting of an output channel by using the ON(1) or OFF(0) key. If the coupling is on, the programmed voltage or current setting will be adjusted to maximum power if one of these settings would cause maximum power to exceed. If the voltage-current coupling is on, it is applicable for all output channels.

3: COUPLE PROT
This function allows the coupling between the protection mechanisms of all available output channels, using the ON(1) or OFF(0) key. If one of the enabled output channels shuts down because of OVP, OCP, or FAIL, all enabled output channels will also be shut down. This situation can be reset by removing the cause of the shutdown and by resetting the protection circuitry of the output channel that caused the shutdown. This will switch on all output channels again to output their programmed values.

4: STBY AT PON
This function defines the 'power on' behavior of your power supply. You can program that behavior to be one of two modes, i.e., the STANDBY mode (press the ON (1) key) or the mode that your supply was in at the moment of power off (press the OFF (0) key).

5: CONTRAST
This function enables you to adjust the contrast of the display by programming a number between 0 and 9. The number 0 presents the lowest contrast, and the number 9 presents the highest contrast.

6: KEY LOCK
This function enables you to lock the keyboard to prevent unauthorized operation. The message KEY LOCK OFF will be displayed. To lock the keyboard, the key ON (1) must be pressed. This will set the display to its previous state. If any key is pressed, the message KEY LOCK ON will be displayed. To unlock the keyboard, the ENTER key must be pressed for at least 5 seconds. If the keyboard has been locked, it is not possible to verify any programmed settings.

7: ADDRESS
This function allows you to verify and/or change the GPIB interface address. The display shows the current address as an integer in the range from 0 to 30. The address can be changed by pressing the numeric keys, then pressing the ENTER key. If a value outside the valid range is input, it will be ignored, and the display will show: `A D D R E S S  M A X =  3 0`

Note: Address 0 is often used as GPIB controller address.

8: instrument identification
This function displays the identity of your power supply. The display will show:
`P M 2 8 x x  V y . y  N : z z`
x x are the last digits of the instrument type number.
y . y is the version of the central processor software.
zz indicates the software version of the output N.
For a multiple output model, the output channel N can be changed using the SELECT key. This enables you to verify the software version of all output channels.

9: CAL CODE
This function allows you to verify and/or set the 4 digit access code, used as the password to enter the calibration mode. This code is initially set at the instrument type number, e.g., 2831. If the correct code is typed, followed by pressing the ENTER key, a request for a new code is done. After the new code has been typed, followed by pressing the ENTER key, a request to verify the code is done. If the new code is typed again, followed by pressing the ENTER key, then the new code is accepted as the new calibration access code. If a new code is not wanted, press the ENTER key after the request for a new code.

Note: Please write down your (new) calibration code. If you forgot your calibration code, refer to section 2.3.1 "Troubleshooting".

Pressing the AUX key again starts the menu from the beginning. You can exit the menu by pressing the ENTER key.
If you turn the power on while keeping the AUX key depressed, your power supply will ask you for the calibration access code before it enters the CALIBRATION mode. By pressing the SELECT key, you can select the output channel to be calibrated. Refer to chapter 2 "MAINTENANCE".

Errors:

`T I M E  M A X =  6 0 . 0 s`	When the maximum step interval time has been exceeded.
`S T A R T  M A X =  9 9 9`	When the maximum start address of the step sequence has been exceeded.
`S T O P  M A X =  9 9 9`	When the maximum stop address of the step sequence has been exceeded.
`A D D R E S S  M A X =  3 0`	When the maximum GPIB interface address has been exceeded.

0 to 9 (numeric keys) (10)

Action: Enter decimal figures.

Display: The decimal figure will be displayed.

Description:

These keys can be used to enter one of the decimal figures 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9.

Example:

Press V 1
The display will show: n V S E T 1 V
Press •
The display will show: n V S E T 1 . V
Press 2
The display will show: n V S E T 1 . 2 V
Press 3
The display will show: n V S E T 1 . 2 3 V
Press ENTER
The display will show: n 1 . 2 3 V d . d d A
(if in the OPERATE mode)

Action: Stores the actual voltage and current settings of all output channels into the recall memory.

Display: S T O R E

Description:

A recall memory consists of 999 addresses, numbered from 1 to 999. A recall memory address contains space for the voltage and current setting of all available output channels.

After a group of settings has been stored, it can be recalled by pressing the RECALL key. If a value outside the valid range is input, it will not be accepted and the display shows: S T O R E M A X = 9 9 9

CAUTION: The voltage and current settings of all output channels are stored to the memory address specified.

Example:

Press [STORE]

The display will show: S T O R E

Press [5] [4]

The display will show: S T O R E 5 4

Press [ENTER]

Now the voltage and current setting of all output channels are stored at memory address 54.

Change the voltage and current setting of the selected output channel by pressing the V and I key + the numeric keys + the ENTER key.

Press [RECAL] [5] [4]

Press [ENTER] to recall the voltage and current setting of all output channels.

Press [V] to check that the previously stored voltage setting of the selected output channel has been restored.

Press [I] to check that the previously stored current setting of the selected output channel has been restored.

Action: Recalls the stored voltage and current settings of all output channels from the recall memory.

Display: R E C A L L

Description:

A recall memory consists of 999 addresses, numbered from 1 to 999. A recall memory address contains space for the voltage and current setting of all available output channels.

After a group of settings is recalled, the display will show the new output voltage and current when your supply is in the OPERATE mode. When your supply is in the STANDBY mode, the new output settings will become active as soon as the OPERATE mode is entered. If a value outside the valid range is input, it will not be accepted, and the display shows:

```
R E C A L L   M A X =  9 9 9
```

Note: When a memory address is recalled, the voltage and current setting of all output channels is restored from that address.

Example:

Press [STORE] [5] [4] [ENTER]

Now the voltage and current setting of all output channels are stored at memory address 54.

Change the voltage and current setting of the selected output channel using the V and I key + the numeric keys + the ENTER key.

Press [RECALL]

The display will show: `R E C A L L`

Press [5] [4]

The display will show: `R E C A L L  5 4`

Press [ENTER] to recall the voltage and current setting of all output channels.

Press [V] to check that the previously stored voltage setting of the selected output channel has been restored.

Press [I] to check that the previously stored current setting of the selected output channel has been restored.

Action: Steps from one recalled group of settings to the next one. This makes it easy to verify or sequentially execute a number of predefined settings.

Display:

- after 1x STEP key : n S T E P T O 1
- address aaa + ENTER key : n S T E P a a a d d . d d V
  Check that the annunciator above the text STEP is displayed.
- after I key : n S T E P a a a e e . e e A (PM2811/12/13)
- after I key : n S T E P a a a e . e e e A (PM2831/31)
- after V key : n S T E P a a a d d . d d V
- after STEP key : n S T E P b b b d d . d d V

Notes: *aaa is the recall address from 1 to 999.*
dd.dd is the new voltage setting
ee.ee (e.eee) is the new current setting
bbb is the address after aaa, i.e., bbb = aaa + 1
In the STANDBY mode, only the new voltage and current setting are shown. In the OPERATE mode the new voltage and current setting are recalled and the read back value displayed.

Description:

After pressing [STEP], the message STEP TO aa (aa is the previous recall address) is displayed. This address can be changed by pressing the numeric keys. The new address is entered by pressing [ENTER]. Then the annunciator above the text STEP on the front panel will be displayed to indicate that the step function is entered.

The voltage or current value to be displayed can be selected at any time by pressing the V or the I key. Any further activation of the STEP key increments the step address. A sequence may be accessed at any address within the predefined range, which is defined in the STEP submenu of the AUX function key (START AT and STOP AT). If an address is entered outside the predefined range, the message INVALID STEP is displayed.

The STEP function can be entered in the OPERATE as well as the STANDBY mode and can be exited by pressing [OPR STBY] or [◀]. The last recalled voltage and current remain actual.

In the OPERATE mode the output settings are updated according to the recalled settings. In the STANDBY mode the contents of the recall addresses can be verified.

The message STEP MAX= 999 is displayed if an address outside the possible range (1 to 999) is entered.

Example:

Press [STEP] to enter the step function.

Press [2] [0] [ENTER] to select address 20.

Sequence:

Select the output channel by pressing [SELECT].

Check the voltage by pressing [V].

Check the current by pressing [I].

Press [STEP] to examine the next address.

Repeat this sequence as many times as necessary.

Error:

I N V A L I D S T E P	Is displayed if an address is entered outside the valid range.
S T E P M A X - 9 9 9	Is displayed if an address is entered outside the possible range.

Action: Executes a command or a function.

Description:

By pressing this key a function will be terminated or a programmed value will be entered.

This key can also be used for removing an error message from the display.

Example:

Press [V] [1]

The display will show: n V S E T 1 V

Press [•] [2] [3]

The display will show: n V S E T 1 . 2 3 V

Press [ENTER]

The display will show: n 1 . 2 3 V d . d d A

(if in the OPERATE mode and in the CV mode)

◀ (backspace) (15)

Action: Erases the input of the previous keystroke.

Display: The text from the last key will be erased from the display.

Description:

This key can be used to correct a wrong keystroke by pressing the backspace key, then pressing the correct key.
This key is also used to leave the step function. Manual as well as automatic stepping through a number of voltage/current settings is aborted by pressing this key.

Example 1:

Press [V] [1] [3]
The display will show: n V S E T 1 3 V
Press [◀] [2]
The display will show: n V S E T 1 2 V
Press [◀] [◀] [ENTER]
The voltage setting has not been changed.

Example 2:

Press [V]
The display will show: n V S E T a a . a a V
Press [◀]
The display will show: n V S E T V
Note: The actual value has been erased from the display
Press [ENTER]
Now the latest voltage is actual again, i.e., the voltage setting has not been changed.

Action: Enters a decimal point.

Display: The display will show the decimal point.

Description:
This key can be used to insert a decimal point into a value to be input.

Example:

Press [V] [1]
The display will show: n V S E T 1 V
Press [•]
The display will show: n V S E T 1 . V
Press [2]
The display will show: n V S E T 1 . 2 V
Press [3]
The display will show: n V S E T 1 . 2 3 V
Press [ENTER]
The display will show: n 1 . 2 3 V d . d d A
(only in the OPERATE mode)

Action: Sets a predefined function or value off or on.

Description:

The OFF key is the same as the 0 key.
The ON key is the same as the 1 key.

Example:

Press [UNMASK] twice.
Press [1] to set the UNMASK-DEN bit ON.
Press [UNMASK]
Press [0] to set the UNMASK-CP bit OFF.
Press [UNMASK]

Action: Adjusts the output current setting.

Display: The actual output voltage and current will be displayed if the power supply is in the OPERATE mode.

Description:

The output current setting will be decreased when you press the left part (- I), and will be increased when you press the right part (I +). The change in current setting depends on the programming resolution (see the specifications in Appendix A).
The change of the output current can be monitored on the display, if the power supply is in the constant current (CC) mode. This key is active only in the OPERATE mode.

Note: Keeping the left or the right part of the key depressed will cause the output current setting to automatically decrease or increase at a rate of 4 times per second after $^1/_2$ second with its LSD value, after 3 seconds with 10 times its LSD value (LSD = least significant digit).

Increasing the output current setting is possible until one of the following conditions occurs:

- The maximum setting of the output current is reached.
- The maximum setting of the output power (Iset x Vset) is reached. In this case there are two possibilities:

- COUPLED_PARAMETERS = ON:
  The power supply will adjust the voltage setting Vset along the constant power characteristic until the maximum setting of the output power is reached. Every time the voltage setting is adjusted, the CP bit in the status register is set.
- COUPLED_PARAMETERS = OFF:
  The power supply will not adjust the settings. The output current increasing will stop at its maximum possible value.

If the constant current (CC) mode is entered before the maximum output power is reached, the annunciator above the text CC is displayed. If the overcurrent protection was enabled in this case, the protection becomes active and the output voltage and current will be reduced to zero.

Note: If [- I +] is pressed while the current is not displayed, the adjustment of the output current setting goes on.

Example:

For this example your power supply must be in the OPERATE mode and in the Constant Current mode of operation, i.e., the annunciator above the text CC should be displayed.

The display will show, e.g.:

n a a . a a V d d . d d A (d . d d d A)

Press the right part of the **– I +** key 6 times.

The display will show, e.g.:

n a a . a a V e e . e e A (e . e e e A)

For a 60V/2A output channel, the value of e.eee should be approximately 6 x 0.5 = 3 mA higher than d.ddd.

Action: Displays the bits in the fault register for the selected output channel and clears the fault register.

Display:

```
n  F A U L T          d d d
n  F A U L T - C P    O F F (or  O N)
n  F A U L T - U N R  O F F (or  O N)
n  F A U L T - F L    O F F (or  O N)
n  F A U L T - O C    O F F (or  O N)
n  F A U L T - O V    O F F (or  O N)
n  F A U L T - C C    O F F (or  O N)
n  F A U L T - C V    O F F (or  O N)
n  N O   F A U L T
```

Description:

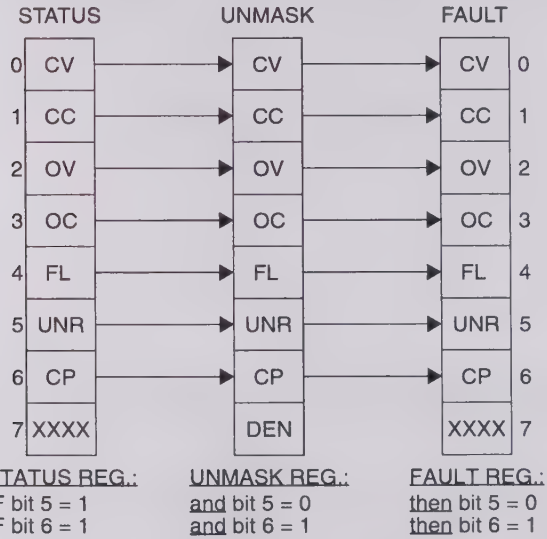
The unmasked events are accumulated in the fault register. The decimal number displayed (ddd) represents the sum of the individual bit values:

BIT:	VALUE:		MEANING:
bit 0 = 1 adds	1	CV	Constant Voltage
bit 1 = 1 adds	2	CC	Constant Current
bit 2 = 1 adds	4	OV	OverVoltage
bit 3 = 1 adds	8	OC	OverCurrent
bit 4 = 1 adds	16	FL	FAILure (overtemperature or out of sense capability)
bit 5 = 1 adds	32	UNR	Unregulated output
bit 6 = 1 adds	64	CP	Coupled Parameters
bit 7 = not used			No meaning
total max. =	127		

Pressing the DISP key again will show whether a bit in the fault register has been set (ON) or not set (OFF). Each time the DISP key is pressed, the next bit will be displayed from the CP up to the CV bit. When a new fault occurs during displaying of the fault register (bits), the new contents of the fault register will be shown by pressing the DISP key again. If no new fault occurred during the display, the message NO FAULT will be displayed at the end.
The DISP function is exited by pressing the ENTER key.
After the fault register has been displayed, the bits are cleared.

Press the SELECT key to select one of the output channels (n).
For unmasking of the bits, refer to the UNMASK key.

The following diagram shows the relation between the STATUS, UNMASK, and FAULT registers: (STATUS and UNMASK = FAULT)



Note: The bits in the fault register have been accumulated in order of occurrence. The sequence of the occurrences cannot be determined from the bit settings.

Example:

Press DISP

The display will show, e.g.: n F A U L T 4 1

The decimal figure 41 is the sum of 32 + 8 + 1.

This means: 1 = bit 0 set, i.e., constant voltage mode
8 = bit 3 set, i.e., overcurrent detected
32 = bit 5 set, i.e., unregulated output

Errors:

After a fault in the selected output channel, the annunciator above the text FLT will be displayed.

Action: Displays or sets the actual unmask setting of the selected output channel.

Display:

1st	time: n	`U N M A S K  d d d`
2nd	time: n	`U N M A S K - D E N  O F F`
3rd	time: n	`U N M A S K - C P  O F F`
4th	time: n	`U N M A S K - U N R  O F F`
5th	time: n	`U N M A S K - F L  O F F`
6th	time: n	`U N M A S K - O C  O F F`
7th	time: n	`U N M A S K - O V  O F F`
8th	time: n	`U N M A S K - C C  O F F`
9th	time: n	`U N M A S K - C V  O F F`

Description:

If a value outside the valid range is input, it will be ignored and the display will show: `U N M A S K  M A X = 2 5 5`

The meaning of the status unmask bits is as follows:

bit 7 = 128 = DEN : Enable the display of a fault message of another output channel (only for multiple output models).
bit 6 = 64 = CP : Coupled parameters have been adapted.
bit 5 = 32 = UNR : Output is unregulated.
bit 4 = 16 = FL : Output channel is in overtemperature or the sense capabilityhas been exceeded (fail).
bit 3 = 8 = OC : Output channel is in overcurrent.
bit 2 = 4 = OV : Output channel is in overvoltage.
bit 1 = 2 = CC : Output channel is in constant current mode.
bit 0 = 1 = CV : Output channel is in constant voltage mode.

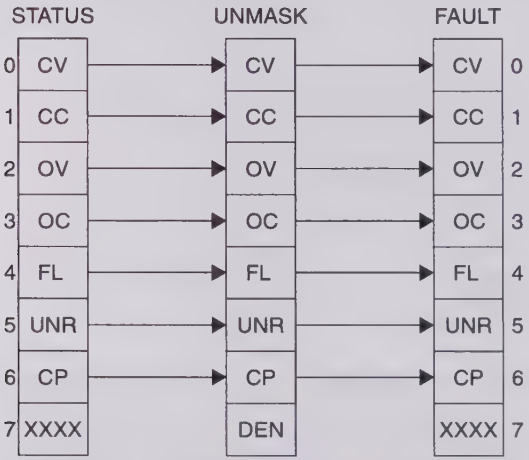
The setting can be changed in two ways:

I) Program a decimal number as the sum of the decimal values of the bits to be set. Programming a 0 clears all the bits in the unmask register, i.e., the status register cannot set any bit in the fault register.

II) Press the key UNMASK sequentially. This will show all the programmable unmask bits that can be set or reset individually, using the ON (1) and OFF (0) keys. Setting a bit ON allows the corresponding bit in the status register to set the corresponding bit in the fault register. Setting a bit OFF disables the corresponding bit in the status register from setting the corresponding bit in the fault register.

Press the SELECT key to select one of the output channels. The menu can be exited by pressing the ENTER key.

The following diagram shows the relation between the STATUS, UNMASK and FAULT registers: (STATUS and UNMASK = FAULT)



Note: The bits in the fault register have been accumulated in order of occurrence. The sequence of the occurrences cannot be determined from the bit settings.

Consider carefully which bits should be masked or not masked from being reported. The FL bit (Failure) and the UNR bit (unregulated output) should always be kept unmasked, i.e., ON.

Example: (using decimal values)

Set the bits 6, 5 and 4 in the unmask register.
The decimal value of bit 6 = 2^6= 64
The decimal value of bit 5 = 2^5= 32
The decimal value of bit 4 = 2^4= 16
total = 112

Press [UNMASK]
The display will show: n U N M A S K d d d
Press [1] [1] [2]
The display will show: n U N M A S K 1 1 2
Press [ENTER] to enter the unmask setting.

Example: (using the ON (1) and OFF (0) keys)

Set the bits 6, 5 and 4 in the unmask register as follows:

Press [UNMASK]
Press [UNMASK] [0] (bit 7 = 0)
Press [UNMASK] [1] (bit 6 = 1)
Press [UNMASK] [1] (bit 5 = 1)
Press [UNMASK] [1] (bit 4 = 1)
Press [UNMASK] [0] (bit 3 = 0)
Press [UNMASK] [0] (bit 2 = 0)
Press [UNMASK] [0] (bit 1 = 0)
Press [UNMASK] [0] (bit 0 = 0)
Press [UNMASK] and check that the unmask setting = 112.
Press [ENTER] to end the unmask setting.

Action: Disables or enables the overcurrent protection.

Display: If enabled, the annunciator pointing at the text OCP EN will be displayed.
If enabled and an overcurrent situation has occurred, the following message is displayed: n O V E R C U R R E N T

Description:

When the overcurrent protection has been enabled and the selected output channel outputs a current that exceeds the programmed output current limit, the output channel will be shut down, i.e., the output is reduced to zero volts and zero amperes. Also the message OVERCURRENT will be displayed. Recovery from this fault situation can be accomplished by removing the cause of the overcurrent, then pressing the RESET key.
When COUPLED PROTECTION is on, the output channel may also be shut down if another coupled output channel is shut down because of an activated protection.

Example:

The power supply is in the Constant Current mode of operation.

Press [OCP EN OCP DIS] to enable the overcurrent protection.

The overcurrent protection circuit for the selected output channel will immediately be activated and the message OVERCURRENT will be displayed. Also the annunciator above the text OCP EN will be displayed.

Press [OCP EN OCP DIS] to disable the overcurrent protection.

Press [RESET] to reset the overcurrent protection curcuit.

Now the power supply is back in Constant Current mode. The annunciator above the text OCP EN is no longer displayed.

Error:

If another coupled output channel has been shut down and the DEN bit has been unmasked, the following is displayed only once after a reset:
n F A U L T O U T P U T m

Action: Verifies or sets the current level of the selected output channel. The output current can be set by pressing the numerical input keys. In step mode the active current is shown when pressing this key.

Display: n I S E T d d . d d A (PM2811/12/13)
n I S E T d . d d d A (PM2831/32)

Description:

Your power supply will round off the entered current setting I_{set} to the nearest multiple of the resolution of the selected output channel (see the specifications in Appendix A).

If a value outside the valid range is entered, it is ignored and the display shows: I S E T M A X = d d A
where dd is the maximum current.
This function is active in the STANDBY mode as well as in the OPERATE mode. Press the SELECT key to select one of the output channels (n).

When [I] is pressed in the step mode, the actual output current is displayed (in the OPERATE mode), or the current setting is displayed (in the STANDBY mode).

Example:

Press [I]
The display will show: n I S E T d . d d d A
Press [0] [•] [2] [3] [4]
The display will show: n I S E T 0 . 2 3 4 A
Press [ENTER] to enter the programmed maximum current level.
If the output channel is in the OPERATE mode and in the CC mode, the display will show: n d d . d d V 0 . 2 3 4 A

PM2811 PM2831

Action: Enables or disables the selected output channel. The enable status of each output channel is indicated on the display by the appearance of the output channel number after the text ENABLED.

Display: If output 1 has been disabled: 1 D I S A B L E D
(and in OPERATE mode) ENABLED
If output 1 was enabled : 1 d d . d d V d d . d d A
(d . d d d A)
(and in OPERATE mode) ENABLED 1

Description:

This key is applicable only for multiple output channel models. A maximum of three output channels can be enabled. This will be indicated on the display as follows: **ENABLED 123**. In this way you can quickly verify which output channels have been enabled to output power.
The enable function, however, is overruled in the STANDBY mode of the power supply, which is selected by pressing the OPR/STBY key. When the output has been disabled, it will behave as if it was programmed to zero volts and zero amperes.
Press the SELECT key to select one of the output channels (n).

Example:

Press SELECT to select output 1 (only applicable for multiple output channel models).
Press ENABLE DISABLE to enable output 1 (only applicable for multiple output channel models).
Press OPR STBY to set the power supply in the OPERATE mode.
The display will show: 1 d d . d d V d . d d d A
ENABLED 1

Action: Resets your power supply to power-on conditions when the recessed RESET button is activated with a pencil point.

Description:

This feature has been implemented to reset your power supply without the need to switch the power off and on.

All programmed values before the system reset remain actual.

The reset behavior can be programmed using the STBY AT PON menu of the AUX function, i.e., continue in the STANDBY mode or in the mode that the power supply was in at the moment of RESET.

1.2.2 Display indicators

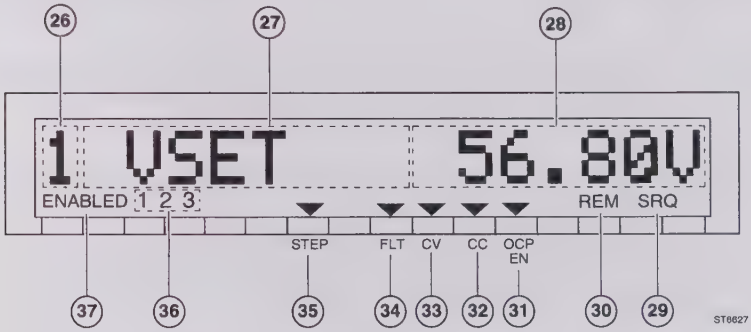


Figure 1.2 Display of the Programmable Power Supply

(26) This digit indicates the channel number (only for multiple output models).

(27) (28) Setting information or actual output values.

(29) **SRQ**
When the text SRQ is displayed, your power supply is requesting for service, i.e., has a message or data for the controller.

(30) **REM**
When the text REM is displayed, your power supply is in the remote mode, i.e. programmed via the GPIB bus.

(31) **OCP EN**
When the annunciator above the text OCP EN is displayed, the overcurrent protection for the selected output channel has been enabled.

(32) **CC**
When the annunciator above the text CC is displayed, the selected output channel is in the Constant Current mode of operation.

(33) **CV**
When the annunciator above the text CV is displayed, the selected output channel is in the Constant Voltage mode of operation.

(34) **FLT**
When the annunciator above the text FLT is displayed, a bit is set in the fault register of the selected output channel.

(35) **STEP**
When the annunciator above the text STEP is displayed, the step function is active.

(36) **1, 2, 3**
The displayed figures indicate which output channels have been enabled. This text is applicable only for multiple output models.

Example:
The display shows **ENABLED2**
This means that output channel 2 has been enabled.

(37) **ENABLED**
The text ENABLED is displayed for multiple output models.

1.3 REMOTE OPERATING INSTRUCTIONS

This section describes each command and query for the programmable power supplies in detail. The commands and queries are listed in alphabetical order. First the IEEE.2 commands/queries (beginning with *) are listed followed by the PPS-specific SCPI commands/queries. Each command description starts on a new page and consists of the following:

- NAME
- Action: Describes what the command/query does.
- Syntax:

  The syntax of the command/query indicates the character sequence that must be placed on the GPIB. Different programming languages (such as BASIC, C, PASCAL) have different ways of representing data that is to be output onto the GPIB. It is up to the programmer to determine the methods to output the character sequence required for the programming language used.

  Commands must be sent to the instrument for which they are intended. This means GPIB device address information must be included before the command sequence. Again the programmer must determine how the programming language can pass this information on to the GPIB.

  Rules:
  - Common commands begin with an asterisk (*).
  - Queries end with a question mark (?).
  - Subsystem command/query parts start with a semicolon (:).
  - The first semicolon (:) in a command may be left out.
  - UPPER case letters in mnemonics are mandatory (short form); lower case letters may be left out or must be specified completely (long form).
    Example: **:INSTrument** (long form) has the same effect as **:INST** (short form)
  - Commands/queries may be given in uppercase or lowercase characters through one another.
    Example: **SoUrCe** is allowed.
  - Text between [and] is optional text.
    Example: **:INST[:SEL]** has the same effect as **:INST**

- Text between { and } may be repeated.
  Example: **<id>{,<id>}** means that the <id> parameter can be repeated, e.g. **<id>,<id>,<id>**
- A choice is indicated by a | sign.
  Example: **0 | 1** means **0 or 1**
- Values can be given in:
  - decimal <value>, e.g. 10
  - hexadecimal #h<value>, e.g. #hA
  - octal #q<value>, e.g. #q12
  - binary #b<value>, e.g. #b1010

- Response: (only in the case of a query)

- Description: (additional information)

- Example: (sending commands and reading responses)

Program examples are included with each command description. **ONLY THE COMMAND STRING IS GIVEN**. No other programming details are shown, because the method used to send the command string will differ depending upon the GPIB drivers and programming language used.

The following example sends the command *CLS to the power supply.
Send → *CLS
The following example reads the response from the power supply
Read ← <response>

- Errors: (possible error numbers + their meaning)
  For errors not mentioned, refer to Appendix D "Error messages".

Note: In the remote mode the front panel keys will have no effect on programmed settings. It is, however, possible to view the actual settings on the front panel display, using the front panel keys SELECT, V, I, OVP, DELAY, UNMASK, DISP, and AUX.

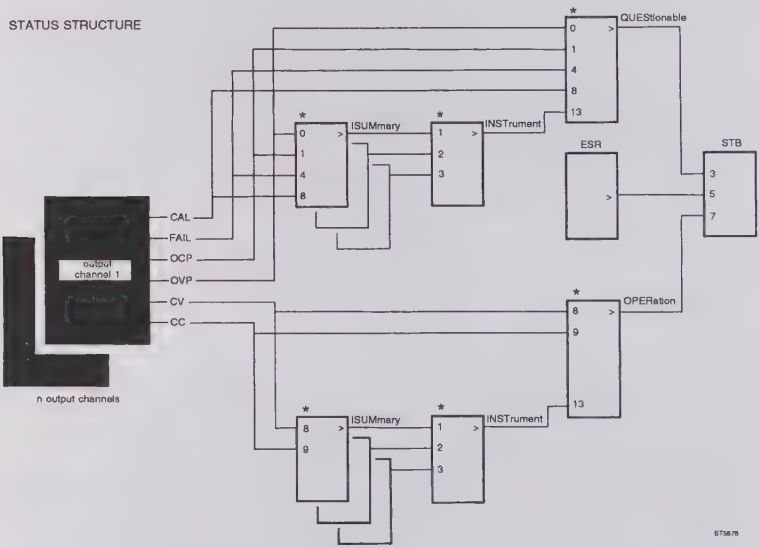


Figure 1.3 Status structure

Register structures marked with an asterisk (*) are composed as shown on the next page.

A status event is active if the corresponding bit = 1 (true) and not active if bit = 0 (false).

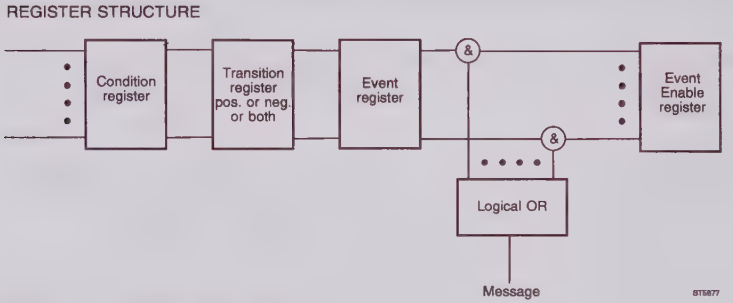


Figure 1.4 Register structure

Each of the following registers contain the above structure:

OUEStionable	OPERation
INSTrument	INSTrument
ISUMmary	ISUMmary

The conditions can be filtered with the transition register for POSitive, NEGative or both transitions. The resulting Events may be enabled or disabled by the Event Enable register.

Remark: According to the SCPI status structure, the status of output channel 1 is accessible through the ISUMmary as well as with the QUEStionable (resp. OPERation) register. The status of the output channels 2 and 3 is accessible only through the ISUMmary register.

*CLS Clear Status Command

Action: Clears the status data structures.

Command: *CLS

Description:

The *CLS command forces the device into the 'operation complete idle' and the 'operation query idle' state and performs the following:

1. Clears all Event Registers summarized in the Status Byte Register.
2. Empties all Queues, which are summarized in the Status Byte Register. The Output Queue, which is summarized in the MAV-bit, will be cleared only when the *CLS command is the only or the first command in a program message.

Example:

Send → *CLS

*ESE Standard Event Status Enable Command

Action: Sets the ESE (standard Event Status Enable) register bits to enable the Standard Events to be summarized in the Status Byte Register.

Command: *ESE <integer>

<integer> A whole positive number in the range 0 to 255.

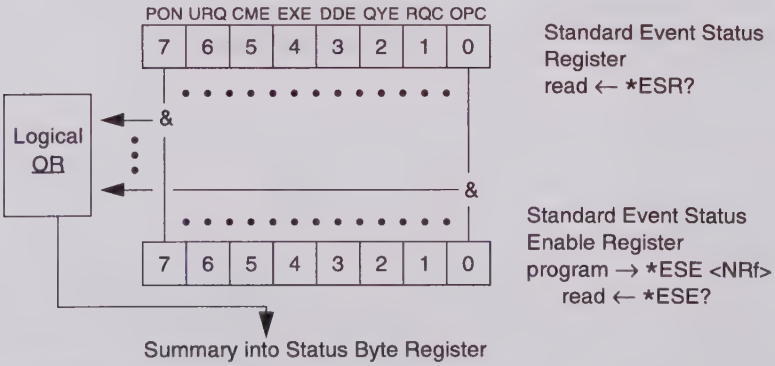
Query: *ESE?

Response: <integer>

Description:

The contents of the Standard Event Status Enable Register (*ESE) determines which bits in the Standard Event Status Register (*ESR) are enabled to be summarized in the Status Byte Register (*STB).

Suppose you want to enable the DDE (Device Dependent Enable) bit to be summarized in the Status Byte Register. Then you have to set bit 3 in the *ESE register by sending the following command string: *ESE 8
When you also want to enable the OPC (Operation Complete) bit, the command string to send must be: *ESE 9


PON URQ CME EXE DDE QYE RQC OPC
7 6 5 4 3 2 1 0
Standard Event Status Register
read ← *ESR?
Logical OR
&
&
Standard Event Status Enable Register
program → *ESE <NRf>
read ← *ESE?
7 6 5 4 3 2 1 0
Summary into Status Byte Register

Example:

Send → *ESE 255 Bits 0 to 7 are enabled
Send → *ESE?
Read ← <response> = 255

*ESR? Standard Event Status Register Query

Action: Reports the contents of the standard Event Status Register (ESR) and clears it.

Query: *ESR

Response: <integer>

<integer> A whole decimal number in the range 0 to 255.

Description:

Send → *ESR?
Read ← 28
The response 28 equals the binary value 00011100 (= 16 + 8 + 4 decimal). The bits 4 (EXE bit), 3 (DDE bit) and 2 (QYE bit) are set. This means that an Execution Error, a Device Dependent Error, and a Query Error occurred since the last time this register was read.

PON	URQ	CME	EXE	DDE	QYE	RQC	OPC
7	6	5	4	3	2	1	0
0	0	0	1	1	1	0	0

Standard Event Status Enable Register
read ← *ESE?

Example:

Send → *ESE 255 Bits 0 to 7 are enabled
Send → *ESR? Read Event Satus Register
Read ← 255

*IDN? Identification Query

Action: Reports the identification of the instrument.

Query: *IDN?

Response: <identity string>

<identity string> =
<Manufacturer>,<Model>,<Serial Number>, <Firmware level>

Description:
The Serial Number and Firmware level data are optional, but if the instrument does not report this data, an ASCII character 0 is returned instead.

Example:
Send → *IDN?
Read ← PHILIPS,PM2832/11,0,V1.0

*OPC Operation Complete Command

Action: Causes the instrument to set the operation complete bit (OPC) in the standard Event Status Register (ESR) when all pending operations have been finished.

Command: *OPC

Query: *OPC?

Response: 1

Description:

When the *OPC command is sent to a unit, it will set the **OPC** bit (=bit 0) in the *ESR register when all pending operations have been completed.

PON	URQ	CME	EXE	DDE	QYE	RQC	**OPC**
7	6	5	4	3	2	1	0

Standard Event Status Enable Register
read ← *ESE?

The OPC bit is cleared along with the other bits in the *ESR register, when the *ESR? query is executed. Another way to wait for the completion of an operation is to use the *WAI command.

Example:

Send → *OPC
.
.
Send → *ESR?
Read ← 0 — Indicates that the instrument is busy performing programmed actions.
.
.
Send → *ESR?
Read ← 1 — Indicates that the instrument has finished the previously programmed actions.

*Note: You may repeat the *ESR? query and read the response until the OPC bit is 1, but you can also use the *OPC? query. The response from the *OPC? query (which is always an ASCII character 1) holds up the GPIB until the previous operations have been completed.*

Example:

Send → <command 1>
Send → *OPC?
Read ← 1 This response is held off until the action performed by <command 1> is completed.

*PSC Power-on Status Clear Command

Action: Disables or enables the clearing of the SRE (Service Request Enable register) and the ESE (standard Event Status Enable register) after power on.

Command: *PSC <integer>

<integer> A whole decimal number in the range -32767 to 32767

Query: *PSC?

Response: 0 if disabled
1 if enabled

Description:
This command enables or disables the clearing of the status registers after power on. If a zero is programmed, the clearing will be disabled. If an integer not equal to zero is programmed, the clearing will be enabled.

Note: *If *PSC was set false (disabled) and a power-up is detected, the status information may be invalid. If this is the case, a device-dependent error is generated (-300, "Device-specific error"). The user can test on this event (bit 3 in the ESR register) by reading the ESR register (*ESR?), which indicates the validity of the status structure.*
*If bit 3 (DDE) is set, the status structure is invalid. The suggested action is sending a *CLS (which clears the status structure). If bit 3 (DDE) is reset, the status structure is valid.*

Examples:

Send → * PSC 1 Clearing enabled.
.
Send → *PSC -34 Clearing enabled.
.
Send → *PSC 0 Clearing disabled.

Send → *PSC?
Read ← 0 No clearing after power on.

*RCL Recall Command

Action: Restores the programmable settings of the instrument from a specified location in the local memory.

Command: *RCL <location>

<location> A whole decimal number in the range 0 to 9

Description:

- <location> is rounded to a whole number.
- Memory location 0 will select the power-on settings.
- The scope of *RCL is the same as the scope of the *RST command.

For storing the programmable settings, refer to the *SAV command.

Example:

Send → *SAV 4 Stores the current settings in memory location 4.

.
.

Send → *RCL 4 Recalls the settings previously stored in memory location 4.

.
.

Send → *RCL 0 Restores the power-on settings

*RST Reset Command

Action: Resets the instrument.

Command: *RST

Description:

The *RST command sets the instrument in the power-on default state.

The *RST command **will not affect:**

- the contents of the Output Queue (see Device Clear)
- the Service Request Enable (*SRE) register
- the standard Event Status Enable (*ESE) register
- the state of the IEEE 488.2 interface
- the power-on status clear flag
- calibration data that affects the device specifications
- the contents of the recall memory locations

The *RST command results in the following settings:

:INSTrument:NSELect	1	
:INSTrument:STATe	OFF (= STANDBY)	
:OUTPut:STATe	OFF (= DISABLED)	
:OUTPut:PROTection:COUPling:STATe	OFF	
:SOURce:VOLTage:LEVel:IMMediate:AMPLitude	MIN	1)
:SOURce:VOLTage:LEVel:IMMediate:AMPLitude:AUTO	OFF	
:SOURce:VOLTage:PROTection:LEVel	MAX	2)
:SOURce:CURRent:LEVel:IMMediate:AMPLitude	MIN	3)
:SOURce:CURRent:LEVel:IMMediate:AMPLitude:AUTO	OFF	
:SOURce:CURRent:PROTection:STATe	OFF	
:SOURce:CURRent:PROTection:DELay	DEF	4)
:SOURce:LIST:INDex:NSELect	MIN (=1)	
:SOURce:LIST:SEQuence:STARt	MIN (=1)	
:SOURce:LIST:SEQuence:STOP	MAX (=999)	
:SOURce:LIST:SOURce	EXT	
:SOURce:LIST:TIMer	0.1 s	
:INITiate:CONTinuous	ON	
:DISPlay:ENABle	ON	
:DISplay:CONTrast	MAX (= 9)	
:SYStem:KLOCk	OFF	
:SYSTem:POCLear	ON	
:CALibration:STATe	ON	

COMMAND (SHORT FORM)*	30V/ 10A/ 60W	60V/ 5A/ 60W	60V/ 10A/ 120W	60V/ 2A	120V/ 1A
1) :VOLT MIN	0.0V	0.0V	0.0V	0.0V	0.0V
2) :VOLT:PROT MAX	32V	62V	62V	62V	122V
3) :CURR MIN	0.04A	0.02A	0.04A	0.04A	0.02A
4) :CURR:PROT:DEL DEF	0.05s	0.1s	0.1s	0.05s	0.1s

* Default nodes are omitted

1) to 4) See previous page.

Example:

Send → *RST

*SAV Save Command

Action: Stores the actual settings of the instrument in a specified location in the local memory.

Command: *SAV <location>

<location> A whole decimal number in the range 0 to 999.

Description:

- <location> is rounded to a whole number
- Memory location 0 will select the current settings to be the power-on setup.
- The scope of *SAV is the same as the scope of the *RST command.

For recalling the settings, refer to the *RCL command.

Example:

Send → *SAV 4 Stores the actual settings in memory location 4.

.
.

Send → *RCL 4 Restores the settings previously stored in memory location 4.

.
.

Send → *SAV 0 Stores the actual settings of the instrument in memory location 0. These settings are selected as the power-on settings.

*SRE Service Request Enable Command

Action: Sets the Service Request Enable (SRE) register.

Command: *SRE <integer>

<integer> A whole decimal number in the range 0 to 255.

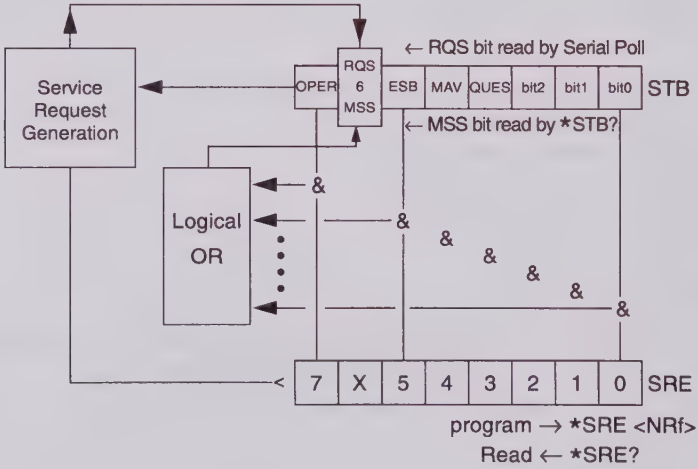
Query: *SRE?

Response: <integer>

Description:

The bits in the Service Request Enable register (*SRE) (see the figure below) determine:

- which corresponding bits in the STatus Byte register (*STB) will cause a service request from the instrument.
- which corresponding bits in the Service Request Enable register (*SRE) will be summarized in the MSS bit in the *STB register.



Example:

Send → *SRE 32 This will set bit 5 in the Service Request Enable register (SRE).

Note: You cannot set or clear bit 6 (decimal value 64). This bit is 'don't care'.

*STB? Read Status Byte Query

Action: Reports the contents of the STatus Byte (STB) register, in which bit 6 reports the MSS (Master Summary Status).

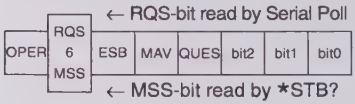
Query: *STB?

Response: <integer>

<integer> A whole decimal number in the range 0 to 255.

Description:

The STatus Byte register contains the summary status of all overlaying status registers and queues. The bits 0 to 5 and bit 7 of this register are summarized in the MSS bit (bit 6); see also the *SRE command. When the Status Byte Register is read by the IEEE 448.2 Serial Poll, then the RQS (Requested Service) bit is returned in bit 6. The *STB query returns the MSS bit in bit 6.



OPER = OPERation status bit
RQS = ReQuested Service
MSS = Master Summary Status
ESB = Event Summary Bit
MAV = Message AVailable
QUES = QUEStionable status bit

Example:

Send → *STB?
Read ← 16 the MAV bit is set, indicating that there is response data available in the unit's Output Queue.

*TRG Trigger Command

Action: Triggers the instrument. This command performs the same as the GPIB defined Group Execute Trigger (= GET) command.

Command: *TRG

Description:

The trigger command *TRG or GET can be used for synchronization of device actions. The *TRG command is an addressed command, just like all other SCPI common commands. This means the trigger command is sent to a certain GPIB address, which means that only one address at a time will receive this trigger. The GET is also an addressed command, but you can send this code to a group of instruments simultaneously. The way this is done depends on the controller language used.

For the programmable power supplies, a trigger command is used to execute the next step during execution of the step function.

Example:

Send → *TRG The addressed instrument will receive a trigger command.

*TST? Self-Test Query

Action: Returns the result of the power-on self-tests.

Query: *TST?

Response: 0 | 1

0 The self-test is completed successfully.

1 The self-test has failed.

Description:

The following self-tests are performed after power-on:

- ROM test
- RAM test
- GPIB controller test
- Microprocessor timer test
- Communication (D^2B) test
- Display controller test
- ADDA output channel(s) test

The only failure that is reported is the display controller test failure. All other failures will be blocked from being reported.

The self-test will not change any internal instrument settings.

Example:

Send → *TST?
Read ← 1 Self-test failed.
.
turn power off and on again
.
Send → *TST?
Read ← 0 Self-test completed successfully.

*WAI Wait-to-Continue Command

Action: Makes the instrument wait until all the previous commands or queries have been completed.

Command: *WAI

Description:
The *WAI command can be used for guaranteed sequential execution of commands and queries. On receipt of the *WAI command, the unit will execute all previous commands and queries before it can execute the next command or query.

Example:
Send → <command 1>
Send → *WAI
Send → <command 2>

Command 2 will be executed only after the action of command 1 has been completed.

*Note: The *OPC? query can also be used to achieve the same effect, but then you must read and wait for the response from this query until the previous programmed command 1 action has been completed.*

:ABORt

Action: Stops the execution of the step function.

Command: :ABORt

Description:
This command can be used to abort the execution of the step function of the power supply (remote equivalent of the (backspace) key). Refer to example 1. This command, in combination with the *SAV and *RCL commands, can also be used to create a pause in the execution of the step function and to restart the step function at a later time. Refer to example 2.

Example 1:

Send → :INIT:CONT	Step function will be executed continuously.
Send → :INIT	Step function is started (initiated).
.	
.	
Send → :ABOR	Step function is stopped (aborted).

Example 2:

Send → *SAV 1;:ABOR	Step function is stored and stopped.
.	
break period (pause)	
.	
Send → *RCL 1	Step function is restarted.

:CALibration:AUTO

Action: Calibrates the overvoltage protection automatically.

Command: :CALibration:AUTO [ONCE]

ONCE Automatic overvoltage calibration is done only once.

Description:

This command is used to automatically calibrate the overvoltage trip level. This command is accepted only when the necessary calibrate conditions are fulfilled. (Refer to chapter 2 MAINTENANCE.) The execution of this command will take a few seconds.

Example:

Send → :INST:NSEL 2 Select output channel 2
.
Calibrate the voltage and the current.
.
Set the minimum calibration point at approximate 10 % of Imax.
Send → :SOUR:CURR:LIM:HIGH?
Read ← Imax
Send → :SOUR:CURR <Imax/10>
Send → :SOUR:FUNC:MODE? Ask for output mode.
Read ← <mode>
IF <mode> = "VOLT" THEN Send → :CAL:AUTO ONCE
This will automatically calibrate the overvoltage for output channel 2.

:CALibration:STATe

Action: Selects if the calibration data is applied or not.

Command: :CALibration:STATe <boolean>

<boolean>	ON | 1	The power supply will use the calibration data for correction.
	OFF | 0	The power supply will not make any correction using the calibration data.

Query: :CALibration:STATe?

Response: <boolean>

Description:
With this command the calibration data can be enabled or disabled to be used. In the normal mode the calibration data has to be used. In the calibration mode, the calibration data must not be used, because it will be calibrated.

Example:

Send → :SYST:UNPR ON	Enables to unprotect calibration.
Send → :SYST:UNPR:SEL 2832	Unprotects the calibration of the power supply by sending the password as calibration access code; default = 2832.

If the password was not correct, error code -221 (Settings conflict) will be generated. This error can be read using the :SYST:ERR? query.

Send → :SYST:UNPR:SEL?	Check that the power supply is in the CAL mode; the response must be: CAL.
Send → :INST:NSEL 1	Selects output channel 1.
Send → :OUTP:STAT ON	Enables output channel 1.
Send → :CAL:STAT OFF	Disables the calibration data to be used.

.
. perform the calibration
.

Send → :OUTP:STAT OFF	Disables the selected output channel.
Send → :SYST:UNPR OFF	Disables the unprotection of the calibration, i.e., the next calibration is protected again.
Send → :CAL:STAT ON	Terminates calibration for the selected output channel, i.e., enables the calibration data to be used again.

:CALibration:VALue

Action: Sends a reference voltage or current to the power supply in the calibration mode.

Command: :CALibration:VALue <num_value>

<num_value> Numeric value representing the reference voltage or current for calibration.

Description:

With this command a reference voltage or current value, measured by a connected multimeter, can be sent to the power supply. This reference value is used to calibrate the voltage or current of the selected output channel. If the output channel mode is VOLTage, the reference value is regarded as a calibrated voltage. If the output channel mode is CURRent, the reference value is regarded as a calibrated current.
This command is effective only in the calibration mode.

Example:

Send → :INST:NSEL 2 Select output channel 2.
Set the minimum calibration point at approximate 10 % of Imax.
Send → :SOUR:CURR:LIM:HIGH?
Read ← Imax
Send → :SOUR:CURR <Imax/10)
Send → :SOUR:VOLT MIN Set the minimum output voltage.
Send → :SOUR:FUNC:MODE? Ask for output channel mode.
Read ← <mode>
IF <mode> = "VOLT" THEN measure the minimum output voltage using a voltmeter; result = <meas_voltage>
Send →:CAL:VAL <meas_voltage>
Now the minimum calibration point for the output voltage of output channel 2 has been set.

:DISPlay:CONTrast

Action: Sets the contrast of the display.

Command: :DISPlay:CONTrast <num_value>

<num_value> Number from 0.0 to 0.9.

Query: :DISPlay:CONTrast?

Response: <num_value>

Description:
The number 0.0 presents the lowest contrast, and the number 0.9 presents the highest contrast.

Example:

Send → :DISP:CONT .9	Text on the display of the power supply is displayed with the highest contrast

:DISPlay:ENABle

Action: Turns the display of the power supply on or off.

Command: :DISPlay:ENABle <boolean>

<boolean>	ON | 1	Display is turned on.
	OFF | 0	Display is turned off.

Query: :DISplay:ENABle?

Response: <boolean>

Description:
If the value of the boolean parameter is a number > 1 (e.g. 34), the display will be turned on.
Returning to the local state will automatically turn on the display.

Example:
Send → :DISP:ENAB ON Display is turned on.

:DISPlay[:WINDow]:TEXT[:DATA]

Action: Displays a message of 16 characters maximum.

Command: :DISPlay[:WINDow]:TEXT[:DATA] <char_string>

<char_string> String of 16 characters maximum.

Query: :DISPlay[:WINDow]:TEXT[:DATA]?

Response: <char_string>

Description:

This command allows you to display a message on the display of your power supply.

Note: The message is cleared by pressing the ENTER key.

Example:

Send → :DISP:ENAB ON
Send → :DISP:TEXT "PPS IS IN USE"
Now the message: **P P S I S I N U S E** will be displayed on the display of the power supply.

:INITiate:CONTinuous

Action: Controls the execution of the step function to be performed continuously or only once.

Command: :INITiate:CONTinuous <boolean>

<boolean>	ON | 1	The sequence list will be executed continuously.
	OFF | 0	The sequence list will be executed once only.

Query: :INITiate:CONTinuous?

Response: <boolean>

Description:
This command is used to control the execution of the step function. If this function is ON, the step function continues its execution after having reached the stop address. If this function is OFF, the step function halts execution after the stop address has been reached. In this case the step function is left with the output settings of the stop address.

Example:

Send → :LIST:SEQ:STAR 10	Start address = 10.
Send → :LIST:SEQ:STOP 19	Stop address = 19.
Send → :LIST:SOUR TIM	Trigger source = internal timer.
Send → :LIST:TIM 1.5	Interval time = 1.5 seconds.
Send → :INIT:CONT 1	Continuous execution = ON.
Send → :INIT	Starts execution of the automatic step function.

:INITiate[:IMMediate]

Action: Starts the execution of the step function.

Command: :INITiate[:IMMediate]

Description:

This command is used to start (initiate) the execution of the step function. The step function starts executing at the programmed start address of the sequence list. Refer to example 1.

The :ABORt command, in combination with the *SAV and *RCL commands, can be used to halt and restart the execution of the step function. Refer to example 2.

Example 1:

Send → :LIST:SEQ:STAR 10	Start address = 10.
Send → :LIST:SEQ:STOP 19	Stop address = 19.
Send → :LIST:SOUR TIM	Trigger source = internal timer.
Send → :LIST:TIM 1.5	Interval time = 1.5 seconds.
Send → :INIT:CONT 1	Continuous execution = ON.
Send → :INIT	Starts execution of the automatic step function.

Example 2:

Send → *SAV 1;:ABOR	Step function is stored and stopped.
.	
break period (pause)	
.	
Send → *RCL 1	Step function is restarted.

:INSTrument:CATalog?

Action: Reports the actual predefined <identifier> for each output channel number.

Query: :INSTrument:CATalog?

Response: <char_string>{,<char_string>}

Description:
This query returns the latest defined identifier for each output channel. The returned output channel identifiers are separated by commas. An empty string is returned if no logical name has been defined (see example).

Example:

Send → :INST:DEL:ALL	Deletes previously defined names.
Send → :INST:DEF OUT 1,1	Defines OUT 1 as indentifier for output channel 1.
Send → :INST:CAT?	Queries the defined indentifiers.
Read ← "OUT 1","",""	OUT 1 is the indentifier for output channel 1. There is no indentifier defined for output channels 2 and 3.

:INSTrument:DEFine

Action: Defines a logical name for an output channel.

Command: :INSTrument:DEFine <identifier>,<num_value>

<identifier>	Logical name
<num_value>	1 (for single output models) 1 or 2 (for dual output models) 1, 2, or 3 (for triple output models)

Query: :INSTrument:DEFine? <num_value>|<identifier>

Response: <identifier> | <num_value>

Description:

This command assigns a logical name to an output channel. Only the last defined logical name for an output channel is valid.
The defined logical names remain unchanged after a *RST command.

The response to the query is the <identifier> if the query contains the <num_value> parameter. Conversely, the response to the query will be the number of the output channel in <num_value> if the query contains the defined <identifier> as the parameter.

Examples:

Send → :INST:DEF OUT2,2	Defines OUT2 as output channel 2.
Send → :INST OUT2	Selects output channel 2.
Send → :INST:DEF OUT1,1	Defines OUT1 as output channel 1.
Send → :INST:DEF? 1	
Read ← OUT1	
Send → :INST:DEF? OUT1	
Read ← 1	

:INSTrument:DELete

Action: Deletes one or all defined logical names for the output channel(s) concerned.

Command: :INSTrument:DELete:ALL
:INSTrument:DELete[:NAME] <identifier>

ALL	Delete all defined names for all output channels.
[:NAME] <identifier>	Delete the name <identifier>.

Description:
A logical name can be assigned to an output channel. With this command the logical name for an output channel or all logical names for all output channels can be deleted.

Example:

Send → :INST:DEL OUT1	Deletes the defined name OUT1.
Send → :INST:DEL:ALL	Deletes all defined names for all available output channels.

:INSTrument:NSELect

Action: Selects the output channel, specified by a number, to be addressed during remote operation.

Command: INStrument:NSELect <num_value>

<num_value> A numeric value specifying which output channel is selected. The range of the numeric value will depend upon the number of output channels the power supply has.

Query: INStrument:NSELect?

Response: <num_value>

Description:

A numeric value has been assigned to each separate output channel and its controlling circuitry. Before a command can be sent to an output channel, it must be selected. An output channel remains selected until another output channel is selected.

Note: The locally and remotely selected output channel does not have to be the same.

Example:

Send → :INST:NSEL 1	Selects output channel 1.
Send → :OUTP ON	Enables output channel 1.
Send → :SOUR:VOLT 7	Sets 7 V output voltage for channel 1.
Send →:INST:NSEL?	Reads back the selected output channel.
Read ← 1	

:INSTrument[:SELect]

Action: Selects the output channel, specified by a logical name, to be addressed during remote operation.

Command: INSTrument[:SELect] <identifier>

<identifier> A logical name specifying which logical output channel is selected.

Query: INSTrument[:SELect]?

Response: <identifier>

Description:

Before a command can be sent to an output channel, it must be selected. An output channel remains selected until another output channel is selected. The <identifier> in this command must first be defined by the INSTRument:DEFine command.

Note: The locally and remotely selected output channel does not have to be the same.

Example:

Send → :INST:DEF out1,1	Defines 'out1' as the logical name for output channel 1.
Send → :INST:SEL out1	Select output channel 1.
Send → :OUTP ON	Enable output channel 1.
Send → :SOUR:VOLT 7	Set 7 V output voltage for channel 1.
Send → :INST?	Queries the selected output identifier.
Read ← "OUT 1"	

:INSTrument:STATe

Action: Places the instrument in the OPERATE or in the STANDBY mode.

Command: :INSTrument:STATe <boolean>

<boolean>	0 | OFF	STANDBY mode.
	1 | ON	OPERATE mode.

Query: :INSTrument:STATe?

Response: <boolean>

Description:

When the power supply is in the STANDBY mode all output channels within the power supply are placed in their inactive state. Instrument settings can be changed but remain inactive until the power supply is placed in the OPERATE mode again.

The mode which the power supply must be in after power on, can be defined with the :SYSTem:POCLear command. At delivery the power supply is factory set at STANDBY after power on.

Example:

Send → :INST:STAT ON	The power supply enters the OPERATE mode.
.	
.	
Send → :INST:STAT OFF	The power supply enters the STANDBY mode.
Send → :INST:STAT?	Queries the mode.
Read ← 1	The power supply is in the OPERATE mode.

:MEASure[:SCALar]:CURRent[:DC]?

Action: Returns the measured current of the selected output channel.

Query: :MEASure[:SCALar]:CURRent[:DC]?

Response: <meas_current> The measured current.

Description:
The actual output current of the selected output channel is returned.

Example:
Send → :MEAS:CURR?
Read ← <meas_value>
Print <meas_value> on the screen of the controller

:MEASure[:SCALar]:VOLTage[:DC]?

Action: Returns the measured voltage of the selected output channel.

Query: :MEASure[:SCALar]:VOLTage[:DC]?

Response: <meas_voltage> The measured voltage.

Description:
The actual output current of the selected output channel is returned.

Example:
Send → :MEAS:VOLT?
Read ← <meas_value>
Print <meas_value> on the screen of the controller.

:OUTPut:PROTection:CLEar

Action: Resets the protection circuits of the selected output channel.

Command: OUTPut:PROTection:CLEar

Description:

When an overvoltage, overcurrent, overtemperature, out of sense capability or coupled protection is detected, the associated protection circuit is tripped and the output voltage and current is reduced to zero. With this command the protection circuit is reset and the output voltage and current restored again. If the protection was caused by 'coupled protection' (refer to the :OUTP:PROT:COUPling commands/queries), an output channel will be reset if the output channel that caused the protection to be tripped has been reset.

Example:
The protection circuits of channels 1, 2 and 3 are coupled.
If channel 1 trips because of overvoltage, output channel 2 and 3 will also trip, causing the output voltage and current to be reduced to zero.
If the cause of the overvoltage for output channel 1 is removed and the protection circuitry is reset, the protection circuitry for output channel 2 and 3 is also reset, causing the output voltage and current to be restored again.

Note: If the cause of a protection tripping has not been removed before reset of the protection circuitry, the protection circuit will immediately trip again.

Example:

Send → :INST:NSEL 1	Selects channel 1.
Send → :OUTP:PROT:CLE	Reset the protection circuits of channel 1.

:OUTPut:PROTection:COUPling[:INSTrument]

Action: Specifies the coupling of the protection circuits of the selected output channel with one or more other output channels within the same power supply.

Command: :OUTPut:PROTection:COUPling[:INSTrument]
<id>{,<id>} | <num>{,<num>} | ALL | NONE

<id>	Logical name for an output channel.	order is arbitrary
<num>	Channel number	
ALL	All channels are coupled.	
NONE	No channels are coupled, i.e., all previously defined couplings are deleted.	

Query: :OUTPut:PROTection:COUPling[:INSTrument]?

Response: <num>{,<num>}

Description:
In one command as many output channels can be coupled as there are present in the power supply. For a dual output model, two output channels can be coupled.
The result of a coupling is that when the protection circuit of one of the coupled output channels trips, the other coupled output channel(s) also trip and behave as if they were disabled. The coupling definition is mutually applicable.
This command defines only the coupled output channels. To make the coupling active, refer to the :OUTP:PROT:COUP:STAT command.

Note: The coupling mechanism for remote operation differs from the local coupling mechanism. The local coupling mechanism is valid for all available output channels. The remote coupling mechanism can be specified per output channel. Be aware of this when switching from local to remote or vice versa !

Example: (for a multiple output model)

Send → :INST:NSEL 1	Output channel 1 selected.
Send → :OUTP:PROT:COUP 2	Output channel 1 coupled to output channel 2.
Send → :OUTP:PROT:COUP:STAT 1	Coupling becomes active.

When the protection circuit of channel 2 trips, that of channel 1 and 3 also trip at the same time
(the same coupling is obtained by sending :OUTP:PROT:COUP ALL)

Send → :OUTP:PROT:COUP:STAT 0	Coupling becomes non-active.
Send → :OUTP:PROT:COUP NONE	Coupling definition is deleted.

:OUTPut:PROTection:COUPling:STATe

Action: Enables or disables the predefined coupling of protection mechanisms.

Command: :OUTPut:PROTection:COUPling:STATe <boolean>

<boolean> 0 | OFF Coupling mechanism disabled.
1 | ON Coupling mechanism enabled.

Query: :OUTPut:PROTection:COUPling:STATe?

Response: <boolean>

Description:
This command enables or disables the protection mechanisms of the output channels, which have been coupled with the OUTPut:PROTection:COUPling[:INSTRument] command. After enabling, the defined coupling is made active.

Example: (for a multiple output model)

Send → :INST:NSEL 1	Output channel 1 selected.
Send → :OUTP:PROT:COUP 2	Output channel 1 coupled to output channel 2.
Send → :OUTP:PROT:COUP:STAT ON	Coupling becomes active.

If the protection circuit of channel 2 trips, that of channel 1 will also trip at the same time.

.
.

Send → :OUTP:PROT:COUP:STAT 0	Coupling becomes non-active.
Send → :OUTP:PROT:COUP NONE	Coupling definition is deleted.

:OUTPut:PROTection:TRIPped?

Action: Reports the current state of the protection circuit of the selected output channel.

Query: :OUTPut:PROTection:TRIPped?

Response: 0|1

0 Protection circuit not tripped.

1 Protection circuit tripped.

Description:

The execution of this query doesn't affect the protection itself. The reason that a protection circuit trips can be one of the following:

- Overvoltage
- Overcurrent
- Overtemperature
- Out of Sense Capability
- Coupled Protection

Example: (for a multiple output model)

Send → :INST:NSEL 1
Send → :OUTP:PROT:TRIP?
Read ← <trip1>
Send → :INST:NSEL 2
Send → :OUTP:PROT:TRIP?
Read ← <trip2>
IF <trip1> = 0 AND <trip2> = 0 THEN print "No output channel tripped"

:OUTPut[:STATe]

Action: Enables or disables the selected output channel.

Command: :OUTPut[:STATe] OFF | ON

OFF | 0 Disables the output of the active output channel, i.e., sets it into the DISABLED state.

ON | 1 Enables the output of the active output channel, i.e., sets it into the ENABLED state.

Query: :OUTPut[:STATe]?

Response: 0|1

Description:
The selected output channel will become active when it is enabled and when the power supply is in the OPERATE mode. If the selected output channel is enabled in the STANDBY mode, its output will become active as soon as the OPERATE mode is entered (see INSTrument:STATe command).

Example:

```
Send → :INST:SEL 1              Select output channel 1.
Send → :OUTP ON                 Enable output channel 1.
Send → :OUTP:PROT:TRIP?
Read ← <trip>
IF <trip> = 0 THEN continue processing
ELSE (examine if tripped because of other output channel)
    BEGIN
        Send → :OUTP:PROT:COUP:STAT?
        Read ← <coup>
        IF <coup> = 0 THEN Send → :OUTP OFF
        Protection circuitry of output channel 1 tripped, so disable output
        channel 1 and stop further processing.
        ELSE (another coupled output channel tripped)
            BEGIN
                Send → :OUTP:PROT:COUP:STAT OFF   Disable coupling.
                Send → :OUTP:PROT:CLE             Reset protection.
            END
    END
continue processing
```

[:SOURce]:CURRent[:LEVel][:IMMediate][:AMPLitude]

Action: Sets the output current for the selected output channel.

Command: [:SOURce]:CURRent[:LEVEL][:IMMEdiate][:AMPLitude]
<current> | MIN | MAX | DEF

<current>	A numeric value in the range MIN to MAX output current of the output channel. After a *RST command, the setting is MIN.
MIN	This parameter will set the output current to its minimum level.
MAX	This parameter will set the output current to its maximum, depending upon the maximum power and the voltage setting.
DEF	This parameter will set the output current to its actual value.

Query: [:SOURce]:CURRent[:LEVEL][:IMMediate][:AMPLitude]?
[MIN | MAX | DEF]

Response: <current>

Description:
The power supply will round off the <current> parameter to the nearest multiple of the resolution of the selected output channel (see the specifications in Appendix A).
If a value outside the valid range is input, it will not be accepted, and error -222 is reported.

Example:

Send → *RST	Output settings become MIN V and MIN A.
Send → :CURR .5	Output current becomes 0.5A.
Send → :VOLT 5	Output voltage becomes 5V.
Send → :CURR?	Query the current setting.
Read ← 0.499	Actual current setting.
Send → :MEAS:CURR?	Current readback query.
Read ← 0.132	Readback current is 132 mA.

[:SOURce]:CURRent[:LEVEL][:IMMediate][:AMPLitude]:AUTO

Action: Enables or disables the coupling of the current and the voltage parameter (only valid for PM2811/12/13).

Command: [:SOURce]:CURRent[:LEVEL][:IMMediate]
[:AMPLitude]:AUTO <boolean>|ONCE

<boolean>	0 | OFF	Parameter coupling disabled.
	1 | ON	Parameter coupling enabled.
ONCE		Coupled only for the next voltage and/or current setting command.

Query: [:SOURce]:CURRent[:LEVEL][:IMMediate][:AMPLitude]:AUTO?

Response: <boolean>

Description:

The range of legal current settings has been related to the voltage setting and the maximum power of the output channel. If the product of a new current setting and voltage setting in one program message exceeds the maximum power, the last setting is not accepted and error - 221 is reported. This can be avoided by using this command to couple the current to the voltage, using this command. The result is that the actual voltage is adjusted according to the formula:

$$V_{set} = \frac{P_{max}}{I_{Set}}.$$

The parameter ONCE is to be used when the current to voltage coupling has to be done only once for the next current or voltage programming.

If the current and voltage setting in one program message does not exceed the max. power, the settings will be accepted without change, e.g.:

- Suppose voltage = 10V and current = 3A.
- The program message :VOLT 30;:CURR 1 will be accepted.

Note: The coupling mechanism for remote operation differs from the local coupling mechanism. The local coupling mechanism is valid for all available output channels. The remote coupling mechanism can be specified per output channel. Be aware of this when switching from local to remote or vice versa!

[:SOURce]:CURRent:LIMit:HIGH?

Action: Returns the maximum current setting of the selected output channel.

Query: [:SOURce]:CURRent:LIMit:HIGH?

Response: <max_current>

<max_current> Maximum current setting.

Description:

This query is used to request the maximum possible current for the selected output channel according to the output channel specific ratings.

Example:

```
Send → :INST:NSEL 1          Selects output channel 1.
Send → :CURR:LIM:HIGH?       Requests for highest current.
Read ← <max_current>
Print "Maximum current = ", <max_current>
```

[:SOURce]:CURRent:LIMit:LOW?

Action: Returns the minimum current setting of the selected output channel.

Query: [:SOURce]:CURRent:LIMit:LOW?

Response: <min_current>

<min_current> Minimum current setting.

Description:
This query is used to request the minimum possible current setting for the selected output channel according to the output channel specific ratings.

Example:

```
Send → :INST:NSEL 1          Selects output channel 1.
Send → :CURR:LIM:LOW?        Requests for lowest current.
Read ← <min_current>
Print "Minimum current = ", <min_current>
```

[:SOURce]:CURRent:PROTection:DELay

Action: Sets the reprogramming delay time for the selected output channel.

Command: [:SOURce]:CURRent:PROTection:DELay <delay_time>
| MIN | MAX | DEF

<delay_time>	Numeric value in the range 0 to 60.0 seconds. The resolution is 1 millisecond. After a *RST command, the default setting is DEF.	
MIN	Sets the minimum delay time.	see Appendix A
MAX	Sets the maximum delay time.	
DEF	Sets the default value.	

Query: [:SOURce]:CURRent:PROTection:DELay? [MIN | MAX | DEF]

Response: <delay_time>

Description:

When the setting of an output channel is altered or after a protection reset, the power supply may change modes momentarily. To prevent the reporting of faults during this momentary switching, a delay can be programmed. This reprogramming delay specifies the time period in which the CC, CV and UNR bits in the status registers will be masked from being reported in the fault register and from activating the overcurrent protection circuit. If a value outside the valid range is input, it will be ignored and error -222 is reported.

The reprogramming delay is active when one of the following functions is executed:

	command:
• V_{set}(voltage setting).	:SOURCE:VOLTAGE
• I_{set} (current setting).	:SOURCE:CURRENT
• ENABLE output channel.	:OUTPUT:STATE ON
• Reset protection.	:OUTPUT:PROTECTION:CLEAR
• Enter OPERATE mode.	:INSTRUMENT:STATE ON

- A recall of voltage /current settings.
- Stepping through voltage/current settings.

Example:

Send → :INST:NSEL 2	Selects output channel 2.
Send → :CURR:PROT:DEL 2.25	Delay becomes 2.25 seconds.

[:SOURce]:CURRent:PROTection:STATe

Action: Enables or disables the overcurrent protection (OCP).

Command: [:SOURce]:CURRent:PROTection:STATe OFF | ON

OFF | 0	This will disable the overcurrent protection (OCP). After a *RST command the setting is OFF.
ON | 1	This will enable the overcurrent protection (OCP).

Query: [:SOURce]:CURRent:PROTection:STATe?

Response: 0|1

Description:
The overcurrent protection (OCP) can be enabled or disabled while the instrument is in the OPERATE or STANDBY mode (see INSTrument:STATe command). When the power supply is in the OPERATE mode and the output channel is enabled, the enabled overcurrent protection becomes active as soon as the reprogramming delay time has expired.

Example:

Send → :INST:NSEL 2	Select output channel 2.
Send → :CURR:PROT:STAT 1	Enable output channel 2.

[:SOURce]:CURRent:PROTection:TRIPped?

Action: Reports whether the overcurrent protection circuit has been tripped.

Query: [:SOURce]:CURRent:PROTection:TRIPped?

Response: 0|1

0 Overcurrent protection circuit not tripped.

1 Overcurrent protection circuit tripped.

Description:
The overcurrent protection (OCP) circuit has been tripped if the maximum current level has been exceeded and the overcurrent protection was enabled.

Example:

```
Send → :CURR:PROT:TRIP?
Read ← <response>
IF <response> = 1 THEN
BEGIN
    Send → :CURR:PROT:STAT 0    Sets the overcurrent protection off.
    Send → :OUTP:PROT:CLE       Resets the overcurrent protection
                                circuitry.
END
```

[:SOURce]:FUNCtion:MODE?

Action: Reports the operating mode of the selected output channel.

Query: [:SOURce]:FUNCtion:MODE?

Response: <character_string>

<character_string> The mode of an output channel can be:

VOLT	Constant voltage output (CV mode).
CURR	Constant current output (CC mode).

Description:
If the power supply is in the STANDBY mode, the response will be VOLT.

Example:
Send → :FUNC:MOD?
Read ← <response>
Send → :INST:NSEL?
Read ← <chan_num>
Print "output channel ",<chan_num>," = ",<response>
As a result the message "output channel N = VOLT" is printed if output channel N was in the CV mode.

[:SOURce]:LIST:CURRent

Action: Sets the specified list of dc current value(s) into subsequent memory addresses, starting from the defined entry address, for the current output channel.

Command: [:SOURce]:LIST:CURRent <num_val>{,<num_val>}

<num_val> Numeric value for the programmed current in the range from MIN to the MAX output current possible. The memory contents are not affected by the *RST command.

Description:

In one command as many current values can be specified as there are addresses to be filled. The filling of addresses is incremental, i.e., 1, 2, 3, etc. After having filled the current of address 999, address 1 is the next one to be filled with the next current specified.

Example:

Send → :INST:NSEL 2 Select output channel 2.
Send → :LIST:IND 10 Select address 10 (entry address).
Send → :LIST:CURR 0.1,0.2,0.3,0.4,0.5,0.6
This will fill the addresses 10, 11, 12, 13, 14, and 15 with the currents 0.1A, 0.2A, 0.3A, 0.4A, 0.5A, and 0.6A, for the selected output channel 2.

[:SOURce]:LIST:CURRent:POINts?

Action: Returns the number of current points in the predefined sequence list for the selected output channel.

Query: [:SOURce]:LIST:CURRent:POINts?

Response: <integer>

<integer> Number of points in the current list from the start address through the stop address.

Description:

As many current points are returned as there are addresses specified from the start address through the stop address. The maximum number is 999.

Example:

Send → :LIST:CURR:POIN?
Read ← <number>
print "the number of current points = "; <number>

[:SOURce]:LIST:GENeration

Action: Generates the default sequence list.

Command: [:SOURce]:LIST:GENeration SEQuence

SEQuence The default sequence in the defined list.

Query: [:SOURce]:LIST:GENeration?

Response: SEQ

Description:
A sequence list begins at the start address and ends at the stop address. When a step function is executed, the sequence list with current and voltage values will be stepped through from the start address through the stop address. The default sequence list is the only possibility (this has been implemented for reasons of SCPI compatibility).

Example:

Send → :LIST:GEN SEQ	Generates the default sequence list.
Send → :INIT	Starts the step function.

[:SOURce]:LIST:INDex[:NSELect]

Action: Selects an entry (index) in the recall memory for all output channels.

Command: [:SOURce]:LIST:INDex[:NSELect] <integer>

<integer> An integer selecting an address in the range of memory addresses. The range is from 1 to 999.

Query: [:SOURce]:LIST:INDex[:NSELect]?

Response: <integer>

Description:

When an entry address has been selected, the corresponding voltage and current for this address (and subsequent addresses if desired) can be programmed, using the LIST:VOLT and :LIST:CURR commands.

Example:

Send → :LIST:IND 10	Selects memory address 10.
Send → :LIST:VOLT 4.9,5.0	Voltage at addr. 10 becomes 4.9V, voltage at addr. 11 becomes 5.0V.
Send → :LIST:CURR 0.23,0.34	Current at addr. 10 becomes 0.23A, current at addr. 11 becomes 0.34A.

[:SOURce]:LIST:SEQuence:STARt

Action: Sets the start address of the sequence list which will be executed in the step mode.

Command: [:SOURce]:LIST:SEQuence:STARt <num_val>

<num_val> A numeric value from 1 to 999 for the start address. The default address after the *RST command is 1.

Query: [:SOURce]:LIST:SEQuence:STARt?

Response: <num_val>

Description:
A sequential list of voltage and current settings can be executed during stepping. The sequence begins at the start address and ends at the stop address. In the continuous step mode, the sequence is repeated continuously. This sequence list is applicable for all enabled output channels. The start address can be specified in the local and in the remote mode of operation.

Example:

Send → :LIST:SOUR TIM	TIMer mode. The next step is defined by the step interval time.
Send → :LIST:TIM 3.5	Step time = 3.5 seconds.
Send → :LIST:SEQ:STAR 10	Start entry is address 10.
Send → :LIST:SEQ:STOP 29	Stop entry is address 29.
Send → :INIT:CONT ON	Continuous stepping.
Send → :INIT	Starts automatic stepping; sequence = 10 to 29, 10 to 29, etc.

[:SOURce]:LIST:SEQuence:STOP

Action: Sets the stop address of the sequence list, which will be executed in the step mode.

Command: [:SOURce]:LIST:SEQuence:STOP <num_val>

<num_val> A numeric value from 1 to 999 for the stop address. The default address after the *RST command is 999.

Query: [:SOURce]:LIST:SEQuence:STOP?

Response: <num_val>

Description:
A sequential list of voltage and current settings can be executed during stepping. The sequence begins at the start address and ends at the stop address. In the continuous step mode, the sequence is repeated continuously. This sequence list is applicable for all enabled output channels. The stop address can be specified in the local and in the remote mode of operation.

Example:

Send → :LIST:SOUR TIM	TIMer mode. The next step is defined by the step interval time.
Send → :LIST:TIM 3.5	Step time = 3.5 seconds.
Send → :LIST:SEQ:STAR 10	Start entry is address 10.
Send → :LIST:SEQ:STOP 29	Stop entry is address 29.
Send → :INIT:CONT ON	Continuous stepping.
Send → :INIT	Starts automatic stepping; sequence = 10 to 29, 10 to 29, etc.

[:SOURce]:LIST:SOURce

Action: Sets the trigger source for the step function.

Command: [:SOURce]:LIST:SOURce <character_string>

<character_string>	EXT	EXTernal means that the STEP-trigger line or a GPIB trigger command becomes the source for the next step to be taken.
	BUS	BUS is identical to EXT
	TIM	TIMer means that the interval timer determines the next step to be taken.

Query: [:SOURce]:LIST:SOURce?

Response: <character_string>

Description:

Automatic stepping can be done in one of the following ways:

- Automatically — In this case the next step is performed when the step interval time has expired. The step interval time for all output channels is defined by the :LIST:TIMer command.
- Externally — In this case the next step is performed when a trigger pulse is entered via the STEP line BNC connector at the rear or when a trigger command is send via the GPIB interface. If the START line of the trigger bus is active (LOW), the STEP line is the trigger source. If the START line is not active (HIGH), the next step is performed at a GET or *TRG command via the GPIB.

The default source setting after the *RST command is TIMer.

Example:

Send → :LIST:SOUR TIM	TIMer mode. The next step is defined by the step interval time.
Send → :LIST:TIM 3.5	Step time = 3.5 seconds.
Send → :LIST:SEQ:STAR 10	Start entry is address 10.
Send → :LIST:SEQ:STOP 29	Stop entry is address 29.
Send → :INIT:CONT ON	Continuous stepping.
Send → :INIT	Starts automatic stepping; sequence = 10 to 29, 10 to 29, etc.

[:SOURce]:LIST:TIMer

Action: Sets the interval time between two consecutive steps.

Command: [:SOURce]:LIST:TIMer <num_value> | MIN | MAX | DEF

<num_value>	This parameter specifies the step interval time in units of 0.001 seconds.
MIN	This parameter sets the minimum step interval time at 0.1 seconds.
MAX	This parameter sets the maximum step interval time at 60 seconds.
DEF	This parameter sets the default step interval time at 0.1 seconds.

Query: [:SOURce]:LIST:TIMer? [MIN | MAX | DEF]

Response: <num_value>

Description:

The time between two consecutive steps in a sequence list is defined by the interval time. The start and stop address of the sequence list are defined with the [:SOUR]:LIST:SEQ:START and [:SOUR]:LIST:SEQ:STOP commands.

Note: Stepping is done for all output channels at the same time with the same start and stop address in the sequence list for each output channel.

Example:

Send → :LIST:SOUR TIM	TIMer mode. The next step is defined by the step interval time.
Send → :LIST:TIM 3.5	Step time = 3.5 seconds.
Send → :LIST:SEQ:STAR 10	Start entry is address 10.
Send → :LIST:SEQ:STOP 29	Stop entry is address 29.
Send → :INIT:CONT ON	Continuous stepping.
Send → :INIT	Starts automatic stepping; sequence = 10 to 29, 10 to 29, etc.

Send → :LIST:TIM MAX

[:SOURce]:LIST:VOLTage

Action: Sets the specified list of voltage value(s) into subsequent memory addresses, starting from the defined entry address, for the current output channel.

Command: [:SOURce]:LIST:VOLTage <num_val>{,<num_val>}

<num_val> Numeric value for the programmed voltage in the range from MIN to the MAX output current possible. The memory contents are not affected by the *RST command.

Description:

In one command as many voltage values can be specified as there are addresses to be filled. The filling of addresses is incremental, i.e., 1, 2, 3, etc. After having filled the voltage of address 99, address 1 is the next one to be filled with the next voltage specified.

Example:

Send → :INST:NSEL 2 Select output channel 2.
Send → :LIST:IND 10 Select address 10 (entry address).
Send → :LIST:VOLT 1.0,1.1,1.2,1.3,1.4,1.5
This will fill the addresses 10, 11, 12, 13, 14, and 15 with the voltages 1.0V, 1.1V, 1.2V, 1.3V, 1.4V, and 1.5V, for the selected output channel 2.

[:SOURce]:LIST:VOLTage:POINts?

Action: Returns the number of voltage points in the predefined sequence list for the selected output channel.

Query: [:SOURce]:LIST:VOLTage:POINts?

Response: <integer>

<integer> Number of points in the voltage list from the start address through the stop address.

Description:

As many voltage points are returned as there are addresses specified from the start address through the stop address. The maximum number is 999.

Example:

Send → :LIST:VOLT:POIN?
Read ← <number>
print "the number of voltage points = "; <number>

[:SOURce]:POWer:LIMit:HIGH?

Action: Returns the maximum available power of the selected output channel.

Query: [:SOURce]:POWer:LIMit:HIGH?

Response: <max_power>

<max_power> Maximum power available.

Description:
This query is used to request the maximum available power for the selected output channel.

Example:

```
Send → :INST:NSEL 1          Selects output channel 1.
Send → :POW:LIM:HIGH?        Requests the highest possible power.
Read ← <max_power>
print "max. power for channel 1 = "; <max_power>; " Watt"
```

[:SOURce]:VOLtage[:LEVel][:IMMediate][:AMPLitude]

Action: Sets the output voltage for the selected output channel.

Command: [:SOURce]:VOLTage[:LEVEL][:IMMEdiate][:AMPLitude] <voltage> | MIN | MAX | DEF

<voltage>	A numeric value in the range 0 to the maximum output voltage of the output channel. After a *RST command the setting is MIN.
MIN	This parameter will set the output voltage to its minimum level.
MAX	This parameter will set the output voltage to its maximum level, depending upon the maximum power and the current setting.
DEF	This parameter will set the output to its actual value.

Query: [:SOURce]:VOLTage[:LEVEL][:IMMEdiate][:AMPLitude]? [MIN | MAX | DEF]

Response: <voltage>

Description:

Your power supply will round off the <voltage> parameter to the nearest multiple of the resolution of the selected output channel (see the specifications in Appendix A).

If a value outside the valid range is input, it will not be accepted, and error -222 is reported.

Example:

Send → *RST	Output settings become MINimum for both voltage and current.
Send → :CURR 1	Output current becomes 1A.
Send → :VOLT 5	Output voltage becomes 5V.
Send → :VOLT?	Query the voltage setting.
Read ← 5.01	Actual current setting.
Send → :MEAS:VOLT?	Voltage readback query.
Read ← 4.99	Readback voltage is 4.99V

[:SOURce]:VOLtage[:LEVel][:IMMediate][:AMPLitude]:AUTO

Action: Enables or disables the coupling of the voltage and the current parameter (only valid for PM2811/12/13).

Command: [:SOURce]:VOLTage[:LEVEL][:IMMediate]
[:AMPLitude]:AUTO <boolean>|ONCE

<boolean>	OFF	Parameter coupling disabled.
	ON	Parameter coupling enabled.
ONCE		Coupled only for the next voltage and/or current setting command.

Query: [:SOURce]:VOLTage[:LEVEL][:IMMediate][:AMPLitude]:AUTO?

Response: <boolean>

Description:

The range of legal voltage settings has been related to the current setting and the maximum power of the output channel. If the product of a new current setting and voltage setting in one program message exceeds the maximum power, the last setting is not accepted and error - 221 is reported. This can be avoided by using the command to couple the voltage to the current. The result is that the actual current is adjusted according to the formula:

$$V_{set} = \frac{P_{max}}{V_{Set}}$$

The parameter ONCE is to be used when the voltage to current coupling has to be done only once for the next current or voltage programming.

If the current and voltage setting in one program message does not exceed the maximum power, the settings will be accepted without change, e.g.:

- suppose voltage = 30V and current = 2A
- the program message :CURR 3;:VOLT 20 will be accepted

Note: The coupling mechanism for remote operation differs from the local coupling mechanism. The local coupling mechanism is valid for all available output channels. The remote coupling mechanism can be specified per output channel. Be aware of this when switching from local to remote or vice versa!

Example: (for a 60W output channel)

Send → :VOLT 20	Voltage becomes 20V.
Send → :CURR:AUTO ON	Current and voltage become coupled.
Send → :CURR 4	Current becomes 4A.
Send → :VOLT?	Read voltage setting.

Read ← <volt><volt> Will be 60W / 4A = 15V (instead of 20V).

[:SOURce]:VOLtage:LIMit:HIGH?

Action: Returns the maximum voltage setting of the selected output channel.

Query: [:SOURce]:VOLTage:LIMit:HIGH?

Response: <max_voltage>

<max_voltage> Maximum voltage.

Description:
This query requests the maximum possible voltage for the selected output channel, according to the output channel specific ratings.

Example:

```
Send → :INST:NSEL 1          Selects output channel 1.
Send → :VOLT:LIM:HIGH?       Requests for highest voltage.
Read ← <max_voltage>
print "maximum voltage = ", <max_voltage>
```

[:SOURce]:VOLtage:LIMit:LOW?

Action: Returns the minimum voltage setting of the selected output channel.

Query: [:SOURce]:VOLTage:LIMit:LOW?

Response: <min_voltage>

<min_voltage> Minimum voltage.

Description:

This query requests the minimum possible voltage setting for the selected output channel, according to the output channel specific ratings.

Example:

```
Send → :INST:NSEL 1          Selects output channel 1.
Send → :VOLT:LIM:LOW?        Requests for lowest voltage.
Read ← <min_voltage>
print "minimum voltage = ", <min_voltage>
```

[:SOURce]:VOLtage:PROTection[:LEVel]

Action: Sets the overvoltage level of the selected output channel.

Command: [:SOURce]:VOLTage:PROTection[:LEVEL]
<overvoltage>|MIN|MAX|DEF

<overvoltage>	Numeric value in the range MINimum to the MAXimum overvoltage of the output channel. After a *RST command the setting is MAX.
MIN	Sets the overvoltage level at the minimum (2V).
MAX	Sets the overvoltage level at the maximum (2V above the maximum output rating).
DEF	This parameter sets the actual value.

Query: [:SOURce]:VOLTage:PROTection[:LEVEL]? [MIN | MAX | DEF]

Response: <overvoltage>

Description:
Your power supply will round off the <overvoltage> parameter to the nearest multiple of the resolution of the selected output channel (see the specifications in Appendix A).
The range of legal overvoltage settings depends upon the maximum overvoltage of the output channel. If this range is exceeded, the overvoltage is not accepted, and error -222 is reported.

Example:

Send → :VOLT 7	Voltage becomes 7V.
Send → :VOLT:PROT 7.15	Overvoltage becomes 7.15V.

[:SOURce]:VOLtage:PROTection:TRIPped?

Action: Reports whether or not the overvoltage protection circuit has been tripped.

Query: [:SOURce]:VOLTage:PROTection:TRIPped?

Response: 0|1

0 Overvoltage protection circuit not tripped.

1 Overvoltage protection circuit tripped.

Description:
If the overvoltage level OV_{set} has been exceeded, the overvoltage protection (OVP) circuit is tripped.

Example:

```
Send → :VOLT:PROT:TRIP?
Read ← <response>
IF <response> = 1 THEN
BEGIN
    Send → :VOLT:PROT MAX    Sets overvoltage protection level at MAX.
    Send → :OUTP:PROT:CLE    Resets overvoltage protection circuit.
END
```

:STATus:OPERation:CONDition?

Action: Reports the contents of the Operation Condition Register.

Query: :STATus:OPERation:CONDition?

Response: <cond_data>

<cond_data> The contents of the Operation Condition Register expressed as an integer value in the effective range 0 to 8960 decimal (allowed = 0 to 65535).

Description:

This query returns the current contents of the Operation Condition Register. The decimal value that is returned is the summation of the decimal value (bit weight) of the individual bits that have been set.

The bits in the Operation Condition Register have the following meaning:

BIT NUMBER	<cond_data> DECIMAL	VALID CONDITIONS
8	256	Output channel 1 is in constant voltage mode.
9	512	Output channel 1 is in constant current mode.
13	8192	INSTrument summary (all Output Channels).
other		---------- Not used. Zero is returned ---------

Example:

Send → :STAT:OPER:COND?
Read ← 8704

The returned value 8704 equals 8192 (bit 13) + 512 (bit 9). This means the INSTrument summary bit is set, and Output channel 1 is in constant current mode.

:STATus:OPERation:ENABle

Action: Sets the enable mask, allowing events that are true in the Operation Event Register to be reported by the Operation summary bit in the Status Byte Register.

Command: :STATus:OPERation:ENABle <enable_mask>

<enable_mask> Integer value in the range 0 to 65535 decimal. The binary representation of the value is placed in the Enable Register and used as the enable mask. Each bit that is set to 1 in the enable mask will enable the corresponding bit in the Operation Event Register to be included in the Operation summary bit. Default = 0.

Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:OPERation:ENABle?

Response: <enable_mask>

Description:

The enable mask allows the actual true conditions in the Operation Event Register to be reported in the Operation summary bit, i.e., bit 7 in the Status Byte Register.

BIT NUMBER	<enable_mask> DECIMAL	ENABLES THE FOLLOWING EVENTS
8	256	Constant voltage mode change of Output channel 1.
9	512	Constant current mode change of Output channel 1.
13	8192	INSTrument summary change (all Output Channels).
other		---------- Don't care ----------

Example:

Send → :STAT:OPER:ENAB 256

This example will enable the event of entering/leaving the Constant Voltage mode of Output channel 1 to be reported by the Operation summary bit (bit 7) in the Status Byte Register. See also the table under :STATus:OPERation:CONDition?

:STATus:OPERation[:EVENt]?

Action: Reports the contents of the Operation Event Register.

Query: :STATus:OPERation[:EVENt]?

Response: <event_data>

<event_data> The contents of the Operation Event Register expressed as an integer value in the effective range 0 to 8960 decimal (allowed = 0 to 65535).

Description:

This query returns the current contents of the Operation Event Register. The decimal value that is returned is the summation of the decimal value (bit weight) of the individual bits that have been set.
The Operation Event Register is cleared when it is read. The key word EVENt is an optional command part.

The event bits have the following meaning:

BIT NUMBER	<event_data> DECIMAL	A CHANGE OCCURRED IN ONE OF THE FOLLOWING CONDITIONS
8	256	Output channel 1 constant voltage mode.
9	512	Output channel 1 constant current mode.
13	8192	INSTrument summary bit for all output channels.
other		---------- Not used. Zero is returned ---------

Example:

Send → :STAT:OPER?
Read ← 8448

The returned decimal value 8448 equals 8192 (bit 13) + 256 (bit 8). This means that Output Channel 1 changed Constant Voltage mode and the Instrument Summary bit changed (has been set or reset).

:STATus:OPERation:NTRansition

Action: Sets the Operation Negative Transition Filter.

Command: :STATus:OPERation:NTRansition <filter_setting>

<filter_setting> Integer value in the effective range 0 to 8960 (allowed = 0 to 65535); default = 0.
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:OPERation:NTRansition?

Response: <filter_setting>

Description:
This Negative Transition Filter specifies which bits in the Operation Condition Register, that make a negative (1 → 0) transition, will set the corresponding bit in the Operation Event Register. For example when you set bit 8 in this filter, it will set bit 8 in the Operation Event Register at the time bit 8 in the Operation Condition Register is reset, i.e., changed from 1 to 0.

BIT NUMBER	<filter_setting> DECIMAL	THE FOLLOWING EVENTS ARE PASSED ON TO THE OPERATION EVENT REGISTER:
8	256	Output channel 1 leaves constant voltage mode.
9	512	Output channel 1 leaves constant current mode.
13	8192	INSTrument summary Condition bit becomes FALSE.
other		---------- Don't care ----------

Example:
Send → :STAT:OPER:NTR 512

This will set bit 9 in the Operation Negative Transition Filter. When Output Channel 1 leaves Constant Current mode, this event is propagated to the Operation Event Register.

:STATus:OPERation:PTRansition

Action: Sets the Operation Positive Transition Filter.

Command: :STATus:OPERation:PTRansition <filter_setting>

<filter_setting> Integer value in the effective range 0 to 8960 (allowed = 0 to 65535); default = 32767.
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:OPERation:PTRansition?

Response: <filter_setting>

Description:
This Positive Transition Filter specifies which bits in the Operation Condition Register, that make a positive (0 → 1) transition, will set the corresponding bit in the Operation Event Register. For example, when you set bit 8 in this filter, it will set bit 8 in the Operation Event Register at the time bit 8 in the Operation Condition Register is set, i.e., changed from 0 to 1.

BIT NUMBER	<filter_setting> DECIMAL	THE FOLLOWING EVENTS ARE PASSED ON TO THE OPERATION EVENT REGISTER:
8	256	Output channel 1 enters constant voltage mode.
9	512	Output channel 1 enters constant current mode.
13	8192	INSTrument summary Condition bit becomes TRUE.
other		---------- Don't care ----------

Example:
Send → :STAT:OPER:PTR 512

This will set bit 9 in the Operation Positive Transition Filter. When Output Channel 1 enters Constant Current mode, this event is propagated to the Operation Event Register.

:STATus:OPERation:INSTrument:CONDition?

Action: Reports the contents of the Operation Instrument Condition Register.

Query: :STATus:OPERation:INSTrument:CONDition?

Response: <cond_data>

<cond_data> The contents of the Operation Instrument Condition Register expressed as an integer value in the range 0 to 14 decimal.

Description:

This query returns the contents of the Operation Instrument Condition Register.

BIT NUMBER	<cond_data> DECIMAL	VALID CONDITIONS
1	2	Summary of Output channel 1.
2	4	Summary of Output channel 2.
other		---------- Not used. Zero is returned ---------

Example:

Send → :STAT:OPER:INST:COND?
Read ← 6

The returned value 6 equals 2 + 4 (bit 1 and 2 set). This means that the Summary bit of the Output Channels 1 and 2 have been set.

:STATus:OPERation:INSTrument:ENABle

Action: Sets the enable mask, which allows events in the Operation Instrument Event Register to be reported in the Instrument summary bit.

Command: :STATus:OPERation:INSTrument:ENABle <enable_mask>

<enable_mask> Integer value in the effective range 0 to 14 (allowed = 0 to 65535); default = 32767.
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:OPERation:INSTrument:ENABle?

Response: <enable_mask>

Description:
This command sets the enable mask, which allows true conditions in the Operation Instrument Event Register to be reported in the Instrument summary bit, i.e., bit 13 in the Operation Status Register.

BIT NUMBER	<enable_mask> DECIMAL	ENABLES THE FOLLOWING EVENTS:
1	2	Summary of Output channel 1 changed.
2	4	Summary of Output channel 2 changed.
other		---------- Don't care ----------

Example:
Send → STAT:OPER:INST:ENAB 6

This enables a change of the summary bit of the Output channels 1 and 2 to be reported in the (operation and questionable) Instrument Summary bit (bit 13).

:STATus:OPERation:INSTrument[:EVENt]?

Action: Reports the contents of the Operation Instrument Event Register.

Query: :STATus:OPERation:INSTrument[:EVENt]?

Response: <event_data>

<event_data> The contents of the Operation Instrument Event Register expressed as an integer value in the effective range 0 to 14 decimal (allowed = 0 to 65535).

Description:

This query returns the contents of the Operation Instrument Event Register. The contents of this register indicate which Output channel has reported an event.

The event register is cleared when it has been read.

BIT NUMBER	<event_data> DECIMAL	A CHANGE OCCURRED IN ONE OF THE FOLLOWING CONDITIONS:
1	2	Summary of Output channel 1 Operation events.
2	4	Summary of Output channel 2 Operation events.
other		---------- Not used. Zero is returned ---------

Example:

Send → :STAT:OPER:INST?
Read ← 6

The returned value 6 equals 2 (bit 1 set) + 4 (bit 2 set). This means that Output Channels 1 and 2 reported some event(s).

:STATus:OPERation:INSTrument:NTRansition

Action: Sets the Operation Instrument Negative Transition Filter.

Command: :STATus:OPERation:INSTrument:NTRansition <filter_setting>

<filter_setting> Integer value in the effective range 0 to 14 (allowed = 0 to 65535); default = 0
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:OPERation:INSTrument:NTRansition?

Response: <filter_setting>

Description:
This Negative Transition Filter specifies which bits in the Operation Instrument Condition Register, that make a negative (1 → 0) transition, will set the corresponding bit in the Operation Instrument Event Register. For example, when you set bit 1 in this filter, it will set bit 1 in the Operation Instrument Event Register at the time bit 1 in the Operation Instrument Condition Register is reset, i.e., changed from 1 to 0.

BIT NUMBER	<filter_setting> DECIMAL	THE FOLLOWING EVENTS ARE PASSED ON TO THE OPERATION INSTRUMENT EVENT REGISTER:
1	2	Summary of Output channel 1 changed from 1 to 0.
2	4	Summary of Output channel 2 changed from 1 to 0.
other		---------- Don't care ----------

Example:
Send → :STAT:OPER:INST:NTR 4

This will set bit 2 in the Operation Negative Transition Filter. Now when the summary bit of Output Channel 2 changes from 1 to 0, this event is propagated to the Operation Instrument Event Register.

:STATus:OPERation:INSTrument:PTRansition

Action: Sets the Operation Instrument Positive Transition Filter.

Command: :STATus:OPERation:INSTrument:PTRansition <filter_setting>

<filter_setting> Integer value in the effective range 0 to 14 (allowed = 0 to 65535); default = 32767
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:OPERation:INSTrument:PTRansition?

Response: <filter_setting>

Description:

This Positive Transition Filter specifies which bits in the Operation Instrument Condition Register, that make a positive (0 → 1) transition, will set the corresponding bit in the Operation Instrument Event Register. For example, when you set bit 1 in this filter, it will set bit 1 in the Operation Instrument Event Register at the time bit 1 in the Operation Instrument Condition Register is set, i.e., changed from 0 to 1.

BIT NUMBER	<filter_setting> DECIMAL	THE FOLLOWING EVENTS ARE PASSED ON TO THE OPERATION INSTRUMENT EVENT REGISTER:
1	2	Summary of Output channel 1 changed from 0 to 1.
2	4	Summary of Output channel 2 changed from 0 to 1.
other		---------- Don't care ----------

Example:

Send → :STAT:OPER:INST:PTR 4

This will set bit 2 in the Operation Positive Transition Filter. Now when the summary bit of Output Channel 2 changes from 0 to 1, this event is propagated to the Operation Instrument Event Register.

:STATus:OPERation:INSTrument:ISUMmary:CONDition?

Action: Reports the contents of an Output channel's Summary Condition Register.

Query: :STATus:OPERation:INSTrument:ISUMmary<suffix>:CONDition?

Response: <cond_data>

<suffix> Specifies the Output channel number 1, 2 or 3.

<cond_data> The contents of the Instrument Summary Condition Register expressed as an integer value in the effective range 0 to 768 decimal (allowed = 0 to 65535).

Description:

This query returns the contents of an Output channel's Summary Condition Register.

BIT NUMBER	<cond_data> DECIMAL	THE OUTPUT CHANNEL, SPECIFIED BY <suffix>, REPORTS THE FOLLOWING CONDITIONS:
8	256	CV - Constant Voltage mode.
9	512	CC - Constant Current mode.
other		---------- Not used. Zero is returned ---------

Example:

Send → :STAT:OPER:INST:ISUM1:COND?

This query requests the contents of the Summary Condition Register of Output channel 1.

Read ← 512

The value 512 equals 2 to the power 9, i.e., bit 9 is true, indicating that the Output channel 1 is in constant current mode.

:STATus:OPERation:INSTrument:ISUMmary:ENABle

Action: Sets the enable mask, which allows events in the Operation Instrument Summary Event Register to be reported in the Operation Instrument Register.

Command: :STATus:OPERation:INSTrument:ISUMmary<suffix>
:ENABle <enable_mask>

<suffix> Specifies the Output channel number 1, 2 or 3.

<enable_mask> Integer value in the effective range 0 to 768 (allowed = 0 to 65535); default = 0.
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:OPERation:INSTrument:ISUMmary<suffix>:ENABle?

Response: <enable_mask>

Description:
This command sets the enable mask, which allows true conditions in the Operation Instrument Summary Event Registers to be reported in the Operation Instrument Register bit 1 (when <suffix> =1), or bit 2 (when <suffix> =2) or bit 3 (when <suffix> =3).

BIT NUMBER	<enable_mask> DECIMAL	THE FOLLOWING EVENTS, REPORTED BY THE OUTPUT CHANNEL, SPECIFIED BY <suffix>, ARE ENABLED:
8	256	CV - Constant Voltage mode change.
9	512	CC - Constant Current mode change.
other		---------- Don't care ----------

Example:
Send → :STAT:OPER:INST:ISUM2:ENAB 256

This enables a change of the Constant Voltage mode of Output Channel 2 to be reported in the Operation Instrument Register bit 2.

:STATus:OPERation:INSTrument:ISUMmary[:EVENt]?

Action: Reports the contents of an Output channel's Summary Event Register.

Query: :STATus:OPERation:INSTrument:ISUMmary<suffix>[:EVENt]?

Response: <event_data>

<suffix> Specifies the Output channel number 1, 2 or 3.

<event_data> The contents of the Instrument Summary Event Register expressed as an integer value in the effective range 0 to 768 decimal (allowed = 0 to 65535).

Description:

This query returns the contents of an Output channel's Summary Event Register. This register collects changes to the contents of the :STATus:OPERation:INSTrument:ISUMmary:CONDition register. The changes are propagated through the transition filters, depending on their settings. The event register is cleared when it has been read.

BIT NUMBER	<event_data> DECIMAL	THE OUTPUT CHANNEL, SPECIFIED BY <suffix>, REPORTS A CHANGE IN ONE OF THE FOLLOWING CONDITIONS:
8	256	CV - Constant Voltage mode.
9	512	CC - Constant Current mode.
other		---------- Not used. Zero is returned ---------

Example:

Send → :STAT:OPER:INST:ISUM1?

This query requests the contents of the Summary Event Register of Output channel 1.

Read ← 512

The value 512 equals 2 to the power 9, i.e., bit 9 is true, indicating that Output channel 1 entered or left the constant current mode determined by the settings of the transition filters.

:STATus:OPERation:INSTrument:ISUMmary:NTRansition

Action: Sets an Output Channel's Operation Instrument Summary Negative Transition Filter.

Command: :STATus:OPERation:INSTrument:ISUMmary<suffix>
:NTRansition <filter_setting>

<suffix> Specifies the Output Channel number 1, 2 or 3.

<filter_setting> Integer value in the effective range 0 to 768 (allowed = 0 to 65535); default = 0.
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:OPERation:INSTrument:ISUMmary<suffix>:NTRansition?

Response: <filter_setting>

Description:
This Negative Transition Filter specifies which bits in the Operation Instrument Condition Register, that make a negative (1 → 0) transition, will set the corresponding bit in the Operation Instrument Event Register. For example, when you set bit 8 in this filter, it will set bit 8 in the Operation Instrument Event Register at the time bit 8 in the Operation Instrument Condition Register is reset, i.e., changed from 1 to 0.

BIT NUMBER	<filter_setting> DECIMAL	THE FOLLOWING EVENTS, WHICH OCCURRED IN THE OUTPUT CHANNEL SPECIFIED BY <suffix>, ARE PASSED ON TO ITS OPERATION INSTRUMENT SUMMARY EVENT REGISTER:
8	256	CV - Output Channel leaves the Constant Voltage mode.
9	512	CC - Output Channel leaves the Constant Current mode.
other		---------- Don't care ----------

Example:
Send → :STAT:OPER:INST:ISUM2:NTR 768

This will set the bits 8 and 9 (256+512) in the Operation Instrument Summary Negative Transition Filter associated with Output Channel 2. Now when Output Channel 2 leaves either the Constant Voltage mode or the Constant Current mode, this event will be propagated to the Operation Instrument Summary 2 Event Register.

:STATus:OPERation:INSTrument:ISUMmary:PTRansition

Action: Sets an Output Channel's Operation Instrument Summary Positive Transition Filter.

Command: :STATus:OPERation:INSTrument:ISUMmary<suffix>
:PTRansition <filter_setting>

<suffix> Specifies the Output Channel number 1, 2 or 3.

<filter_setting> Integer value in the effective range 0 to 768 (allowed = 0 to 65535); default = 32767
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:OPERation:INSTrument:ISUMmary<suffix>:PTRansition?

Response: <filter_setting>

Description:
This Positive Transition Filter specifies which bits in the Operation Instrument Condition Register, that make a positive (0 → 1) transition, will set the corresponding bit in the Operation Instrument Event Register. For example, when you set bit 8 in this filter, it will set bit 8 in the Operation Instrument Event Register at the time bit 8 in the Operation Instrument Condition Register is set, i.e., changed from 0 to 1.

BIT NUMBER	<filter_setting> DECIMAL	THE FOLLOWING EVENTS, WHICH OCCURRED IN THE OUTPUT CHANNEL SPECIFIED BY <suffix>, ARE PASSED ON TO ITS OPERATION INSTRUMENT SUMMARY EVENT REGISTER:
8	256	CV - Output Channel enters the Constant Voltage mode.
9	512	CC - Output Channel enters the Constant Current mode.
other		---------- Don't care ----------

Example:
Send → :STAT:OPER:INST:ISUM2:PTR 768

This will set bits 8 and 9 (256+512) in the Operation Instrument Summary Positive Transition Filter associated with Output Channel 2. Now when Output Channel 2 enters either the Constant Voltage mode or the Constant Current mode, this event will be propagated to the Operation Instrument Summary 2 Event Register.

:STATus:PRESet

Action: Presets the following status registers to all zeros or all ones:
- OPERation
- QUEStionable
- ISUMmary
- INSTrument

Command: :STATus:PRESet

Description:
By sending this command the following status registers are preset as follows:

- OPERation	ENABle	All bits preset to zero.
	PTRansition	All bits preset to one (32767).
	NTRansition	All bits preset to zero.
- QUEStionable	ENABle	All bits preset to zero.
	PTRansition	All bits preset to one (32767).
	NTRansition	All bits preset to zero.
- ISUMmary	ENABle	All bits preset to zero.
	PTRansition	All bits preset to one (32767).
	NTRansition	All bits preset to zero.
- INSTrument	ENABle	All bits preset to one (32767).
	PTRansition	All bits preset to one (32767).
	NTRansition	All bits preset to zero.

Example:
Send → :STAT:PRES Presets the status registers as indicated above.

:STATus:QUEStionable:CONDition?

Action: Reports the contents of the Questionable Condition Register.

Query: :STATus:QUEStionable:CONDition?

Response: <cond_data>

<cond_data> The contents of the Questionable Condition Register expressed as an integer value in the range 0 to 8467 decimal.

Description:

This query returns the current contents of the Questionable Condition Register. The decimal value that is returned is the summation of the decimal value (bit weight) of the individual bits that have been set.

The bits in the Questionable Condition Register have the following meaning:

BIT NUMBER	<cond_data> DECIMAL	VALID CONDITIONS:
0	1	Output channel 1 OverVoltage Protection active.
1	2	Output channel 1 OverCurrent Protection active.
4	16	Output channel 1 out of sense capability, or in overtemperature.
8	256	Calibration value of Output channel 1 is invalid or lost.
13	8192	INSTrument summary (related to the Output channels).
other		---------- Not used. Zero is returned ---------

Example:

Send → :STAT:QUES:COND?
Read ← 256

The returned value 256 equals 2 to the power 8 (bit 8 is set). This means that Output channel 1 has invalid calibration data or has lost its calibration data.

:STATus:QUEStionable:ENABle

Action: Sets the enable mask, allowing events that are true in the Questionable Event Register to be reported by the Questionable summary bit in the Status Byte Register.

Command: :STATus:QUEStionable:ENABle <enable_mask>

<enable_mask> Integer value in the range 0 to 65535 decimal. The binary representation of the value is placed in the Enable Register and used as the enable mask. Each bit that is set to 1 in the enable mask will enable the corresponding bit in the Questionable Event Register to be included in the Questionable summary bit. Default = 0.
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:QUEStionable:ENABle?

Response: <enable_mask>

Description:
The enable mask allows the actual true conditions in the Questionable Event Register to be reported in the Questionable summary bit, i.e., bit 5 in the Status Byte Register.

BIT NUMBER	<enable_mask> DECIMAL	ENABLES THE FOLLOWING EVENTS:
0	1	Output channel 1 OverVoltage Protection becomes active or is deactivated (protection reset).
1	2	Output channel 1 OverCurrent Protection becomes active or is deactivated (protection reset).
4	16	Output channel 1 detects out of sense capability or overtemperature, or the protection circuit is reset.
8	256	Calibration value of Output channel 1 is invalid or becomes valid again.
13	8192	INSTrument summary bit is set or reset
other		---------- Don't care ----------

Example:

Send → :STAT:QUES:ENAB 256

This example will enable Constant Current mode event of Output channel 1 to be reported by the Questionable summary bit (bit 3) in the Status Byte Register.

:STATus:QUEStionable[:EVENt]?

Action: Reports the contents of the Questionable Event Register.

Query: :STATus:QUEStionable[:EVENt]?

Response: <event_data>

<event_data> The contents of the Questionable Event Register expressed as an integer value in the effective range 0 to 8467 decimal (allowed = 0 to 65535).

Description:

This query returns the current contents of the Questionable Event Register. The decimal value that is returned is the summation of the decimal value (bit weight) of the individual bits that have been set.

The Questionable Event Register is cleared when it is read. The keyword EVENt is an optional command part.

The event bits have the following meaning:

BIT NUMBER	<event_data> DECIMAL	A CHANGE OCCURRED IN ONE OF THE FOLLOWING CONDITIONS:
0	1	Channel 1 OverVoltage Protection active.
1	2	Channel 1 OverCurrent Protection active.
4	16	Channel 1 out of Sense Capability or in overtemperature.
8	256	Channel 1 Calibration value invalid or lost.
13	8192	INSTrument summary bit set.
other		---------- Not used. Zero is returned ---------

Example:

Send → :STAT:QUES?
Read ← 256

The returned value 256 equals 2 to the power 8, which means that bit 8 is set. This indicates that Output Channel 1 has invalid calibration data or that data was lost.

:STATus:QUEStionable:NTRansition

Action: Sets the Questionable Negative Transition Filter.

Command: :STATus:QUEStionable:NTRansition <filter_setting>

<filter_setting> Integer value in the effective range 0 to 8467 (allowed = 0 to 65535); default = 0
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:QUEStionable:NTRansition?

Response: <filter_setting>

Description:
This Negative Transition Filter specifies which bits in the Questionable Condition Register, that make a negative (1 → 0) transition, will set the corresponding bit in the Questionable Event Register. For example, when you set bit 4 in this filter, it will set bit 4 in the Questionable Event Register at the time bit 4 in the Questionable Condition Register is reset, i.e., changed from 1 to 0.

BIT NUMBER	<filter_setting> DECIMAL	THE FOLLOWING EVENTS ARE PASSED ON TO THE QUESTIONABLE EVENT REGISTER:
0	1	Output channel 1 OverVoltage Protection is reset.
1	2	Output channel 1 OverCurrent Protection is reset.
4	16	Output channel 1 protection circuit that detected out of sense capability or overtemperature is reset.
8	256	Calibration value of Output channel 1 is valid again.
13	8192	INSTrument summary is reset.
other		---------- Don't care ----------

Example:
Send → :STAT:QUES:NTR 256

This will set bit 8 in the Questionable Negative Transition Filter. Now when the Calibration value of Output Channel 1 becomes valid again, this event is propagated to the Questionable Event Register.

:STATus:QUEStionable:PTRansition

Action: Sets the Questionable Positive Transition Filter.

Command: :STATus:QUEStionable:PTRansition <filter_setting>

<filter_setting> Integer value in the effective range 0 to 8467 (allowed = 0 to 65535); default = 32767
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:QUEStionable:PTRansition?

Response: <filter_setting>

Description:

This Positive Transition Filter specifies which bits in the Questionable Condition Register, that make a positive (0 → 1) transition, will set the corresponding bit in the Questionable Event Register. For example, when you set bit 4 in this filter, it will set bit 4 in the Questionable Event Register at the time bit 4 in the Questionable Condition Register is set, i.e., changed from 0 to 1.

BIT NUMBER	<filter_setting> DECIMAL	THE FOLLOWING EVENTS ARE PASSED ON TO THE QUESTIONABLE EVENT REGISTER:
0	1	Output channel 1 OverVoltage Protection becomes active.
1	2	Output channel 1 OverCurrent Protection becomes active.
4	16	Output channel 1 detected out of sense capability or overtemperature.
8	256	Calibration value of Output channel 1 becomes invalid
13	8192	INSTrument summary is set.
other		---------- Don't care ----------

Example:

Send → :STAT:QUES:PTR 256

This will set bit 8 in the Questionable Positive Transition Filter. Now when the Calibration value of Output Channel 1 becomes invalid, this event is propagated to the Questionable Event Register.

:STATus:QUEStionable:INSTrument:CONDition?

Action: Reports the contents of the Questionable Instrument Condition Register.

Query: :STATus:QUEStionable:INSTrument:CONDition?

Response: <cond_data>

<cond_data> The contents of the Questionable Instrument Condition Register expressed as an integer value in the effective range 0 to 14 decimal (allowed = 0 to 65535)

Description:
This query returns the contents of the Questionable Instrument Condition Register.

BIT NUMBER	<cond_data> DECIMAL	VALID CONDITIONS
1	2	Summary of Output channel 1.
2	4	Summary of Output channel 2
3	8	Summary of Output channel 3
other		---------- Not used. Zero is returned ---------

Example:
Send → :STAT:QUES:INST:COND?
Read ← 6

The returned value 6 equals 2 + 4 (bit 1 and 2 set). This means that the summary bits of the Output Channels 1 and 2 have been set.

:STATus:QUEStionable:INSTrument:ENABle

Action: Sets the enable mask, which allows events in the Questionable Instrument Event Register to be reported in the Instrument summary bit.

Command: :STATus:QUEStionable:INSTrument:ENABle <enable_mask>

<enable_mask> Integer value in the effective range 0 to 14 (allowed = 0 to 65535); default = 32767.
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:QUEStionable:INSTrument:ENABle?

Response: <enable_mask>

Description:
This command sets the enable mask, which allows true conditions in the Questionable Instrument Event Register to be reported in the Instrument summary bit, i.e., bit 13 in the Questionable Status Register.

BIT NUMBER	<enable_mask> DECIMAL	ENABLES THE FOLLOWING EVENTS:
1	2	Summary of Output channel 1 changed.
2	4	Summary of Output channel 2 changed.
3	8	Summary of Output channel 3 changed.
other		---------- Don't care ----------

Example:
Send → STAT:QUES:INST:ENAB 6

This enables a change of the summary bit of the Output channels 1 and 2 to be reported in the Instrument Summary bit (bit 13).

:STATus:QUEStionable:INSTrument[:EVENt]?

Action: Reports the contents of the Questionable Instrument Event Register.

Query: :STATus:QUEStionable:INSTrument[:EVENt]?

Response: <event_data>

<event_data> The contents of the Questionable Instrument Event Register expressed as an integer value in the range 0 to 14 decimal.

Description:

This query returns the contents of the Questionable Instrument Event Register. The contents indicate which Output channel reported a Questionable event.

The event register is cleared when it has been read.

BIT NUMBER	<event_data> DECIMAL	A CHANGE OCCURRED IN ONE OF THE FOLLOWING CONDITIONS:
1	2	Summary of Output channel 1 Questionable events.
2	4	Summary of Output channel 2 Questionable events.
3	8	Summary of Output channel 3 Questionable events.
other		---------- Not used. Zero is returned ---------

Example:

Send → :STAT:QUES:INST?
Read ← 6

The returned value 4 indicates that bit 2 is set. This means that Output channel 2 reported some Questionable event.

:STATus:QUEStionable:INSTrument:NTRansition

Action: Sets the Questionable Instrument Negative Transition Filter.

Command: :STATus:QUEStionable:INSTrument:NTRansition <filter_setting>

<filter_setting> Integer value in the effective range 0 to 14 (allowed = 0 to 65535); default = 0
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:QUEStionable:INSTrument:NTRansition?

Response: <filter_setting>

Description:
This Negative Transition Filter specifies which bits in the Questionable Instrument Condition Register, that make a negative (1 → 0) transition, will set the corresponding bit in the Questionable Instrument Event Register. For example, when you set bit 4 in this filter, it will set bit 4 in the Questionable Instrument Event Register at the time bit 4 in the Questionable Instrument Condition Register is reset (changed from 1 to 0).

BIT NUMBER	<filter_setting> DECIMAL	THE FOLLOWING EVENTS ARE PASSED ON TO THE QUESTIONABLE INSTRUMENT EVENT REGISTER:
1	2	Summary of Output channel 1 changed from 1 to 0.
2	4	Summary of Output channel 2 changed from 1 to 0.
3	8	Summary of Output channel 3 changed from 1 to 0.
other		---------- Don't care ----------

Example:
Send → :STAT:QUES:INST:NTR 4

This will set bit 2 in the Questionable Negative Transition Filter. Now when the summary bit of Output Channel 2 changes from 1 to 0, this event is propagated to the Questionable Instrument Event Register.

:STATus:QUEStionable:INSTrument:PTRansition

Action: Sets the Questionable Instrument Positive Transition Filter.

Command: :STATus:QUEStionable:INSTrument:PTRansition <filter_setting>

<filter_setting> Integer value in the effective range 0 to 14 (allowed = 0 to 65535); default = 32767
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:QUEStionable:INSTrument:PTRansition?

Response: <filter_setting>

Description:
This Positive Transition Filter specifies which bits in the Questionable Instrument Condition Register, that make a positive (0 → 1) transition, will set the corresponding bit in the Questionable Instrument Event Register. For example, you set bit 4 in this filter, it will set bit 4 in the Questionable Instrument Event Register at the time bit 4 in the Questionable Instrument Condition Register is set (changed from 0 to 1).

BIT NUMBER	<filter_setting> DECIMAL	THE FOLLOWING EVENTS ARE PASSED ON TO THE QUESTIONABLE INSTRUMENT EVENT REGISTER:
1	2	Summary of Output channel 1 changed from 0 to 1.
2	4	Summary of Output channel 2 changed from 0 to 1.
3	8	Summary of Output channel 3 changed from 0 to 1.
other		---------- Don't care ----------

Example:
Send → :STAT:QUES:INST:PTR 4

This will set bit 2 in the Questionable Positive Transition Filter. Now when the summary bit of Output Channel 2 changes from 0 to 1, this event is propagated to the Questionable Instrument Event Register.

:STATus:QUEStionable:INSTrument:ISUMmary:CONDition?

Action: Reports the contents of an Output channel's Summary Condition Register.

Query: :STATus:QUEStionable:INSTrument:ISUMmary<suffix>:CONDition?

Response: <cond_data>

<suffix> Specifies the output channel number 1, 2 or 3.

<cond_data> The contents of the Instrument Summary Condition Register expressed as an integer value in the range 0 to 275 decimal.

Description:

This query returns the contents of the Summary Condition Register of the specified output channel.

BIT NUMBER	<cond_data> DECIMAL	THE OUTPUT CHANNEL, SPECIFIED BY <suffix>, REPORTS THE FOLLOWING CONDITIONS:
0	1	OverVoltage Protection active.
1	2	OverCurrent Protection active.
4	16	Out of sense capability or overtemperature.
8	256	CAL - Calibration invalid or lost.
other		---------- Not used. Zero is returned ---------

Example:

Send → :STAT:QUES:INST:ISUM1:COND?

This asks the contents of the Questionable Instrument Summary Condition Register of Output channel 1.

Read ← 256

The value 256 equals 2 to the power 8, i.e., bit 8 is true, indicating that the Output channel 1 has invalid Calibration data.

:STATus:QUEStionable:INSTrument:ISUMmary:ENABle

Action: Sets the enable mask, which allows events in the Questionable Instrument Summary Event Register to be reported in the Questionable Instrument Register.

Command: :STATus:QUEStionable:INSTrument:ISUMmary<suffix>
:ENABle <enable_mask>

<suffix> Specifies the output channel number 1, 2 or 3.

<enable_mask> Integer value in the effective range 0 to 275 (allowed = 0 to 65535); default = 0
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:QUEStionable:INSTrument:ISUMmary<suffix>:ENABle?

Response: <enable_mask>

Description:
This command sets the enable mask, which allows true conditions in the Questionable Instrument Summary Event Registers to be reported in the Questionable Instrument Register bit 1 (when <suffix> =1) or, bit 2 (when <suffix> =2).

BIT NUMBER	<enable_mask> DECIMAL	THE FOLLOWING EVENTS, REPORTED BY THE OUTPUT CHANNEL, SPECIFIED BY <suffix>, ARE ENABLED:
0	1	OverVoltage Protection becomes active or is deactivated (protection reset).
1	2	OCP - OverCurrent Protection becomes active or is deactivated (protection reset).
4	16	Out of sense capability or overtemperature or the protection circuit is reset.
8	256	Calibration value becomes invalid or becomes valid again.
other		---------- Don't care ----------

Example:
Send → :STAT:QUES:INST:ISUM2:ENAB 256

This enables the event of Calibration data becoming valid or invalid in Output Channel 2 to be reported in the Questionable Instrument Register bit 2.

:STATus:QUEStionable:INSTrument:ISUMmary[:EVENt]?

Action: Reports the contents of an Output channel's Summary Event Register.

Query: :STATus:QUEStionable:INSTrument:ISUMmary<suffix>[:EVENt]?

Response: <event_data>

<suffix> Specifies the Output channel number 1, 2 or 3.

<event_data> The contents of the Instrument Summary Event Register expressed as an integer value in the range 0 to 275 decimal.

Description:

This query returns the contents of the Summary Event Register of the specified output channel.

The event register is cleared when it has been read.

BIT NUMBER	<event_data> DECIMAL	THE OUTPUT CHANNEL, SPECIFIED BY <suffix>, REPORTS A CHANGE IN ONE OF THE FOLLOWING CONDITIONS:
0	1	OverVoltage Protection active.
1	2	OverCurrent Protection active.
4	16	Out of sense capability or overtemperature.
8	256	Calibration invalid.
other		---------- Not used. Zero is returned ---------

Example:

Send → :STAT:QUES:INST:ISUM1?

This asks the contents of the Summary Event Register of Output channel 1.

Read ← 256

The returned decimal value 256 indicates that the Calibration data of Output Channel 1 have been lost or became invalid, or the Calibration data becomes valid again after being lost or invalid.

:STATus:QUEStionable:INSTrument:ISUMmary:NTRansition

Action: Sets the Questionable Instrument Negative Transition Filter.

Command: :STATus:QUEStionable:INSTrument:ISUMmary<suffix>
:NTRansition <filter_setting>

<suffix> Specifies the Output channel number 1, 2 or 3.

<filter_setting> Whole decimal number in the effective range 0 to 275 (allowed = 0 to 65535); default = 0
Values can be given in:
- decimal <value>
- hexadec. #h<value>
- octal #q<value>
- binary #b<value>

Query: :STATus:QUEStionable:INSTrument:ISUMmary<suffix>:NTRansition?

Response: <filter_setting>

Description:
This Negative Transition Filter specifies which bits in the Questionable Instrument Condition Register, that make a negative (1 → 0) transition, will set the corresponding bit in the Questionable Instrument Event Register. For example, when you set bit 4 in this filter, it will set bit 4 in the Questionable Instrument Event Register at the time bit 4 in the Questionable Instrument Condition Register is reset (changed from 1 to 0).

BIT NUMBER	<filter_setting> DECIMAL	THE FOLLOWING EVENTS, WHICH OCCURRED IN THE OUTPUT CHANNEL SPECIFIED BY <suffix>, ARE PASSED ON TO ITS OPERATION INSTRUMENT SUMMARY EVENT REGISTER:
0	1	OverVoltage Protection is reset.
1	2	OverCurrent Protection is reset.
4	16	Reset of the protection circuit that detected out of sense capability or overtemperature.
8	256	Calibration data becomes valid again.
other		---------- Don't care ----------

Example:

Send → :STAT:QUES:INST:ISUM2:NTR 256

This will set bit 8 in the Questionable Instrument Summary Negative Transition Filter associated with Output Channel 2. Now when the calibration data of Output Channel 2 become valid again (after being lost or becoming invalid), this event will be propagated to the Questionable Instrument Summary 2 Event Register.

:STATus:QUEStionable:INSTrument:ISUMmary:PTRansition

Action: Sets the Questionable Instrument Positive Transition Filter.

Command: :STATus:QUEStionable:INSTrument:ISUMmary<suffix>
:PTRansition <filter_setting>

<suffix> Specifies the Output channel number 1, 2 or 3.

<filter_setting> Integer value in the range 0 to 275;
default = 32767

Query: :STATus:QUEStionable:INSTrument:ISUMmary<suffix>:PTRansition?

Response: <filter_setting>

Description:

This Positive Transition Filter specifies which bits in the Questionable Instrument Condition Register, that make a positive (0 → 1) transition, will set the corresponding bit in the Questionable Instrument Event Register. For example, when you set bit 4 in this filter, it will set bit 4 in the Questionable Instrument Event Register at the time bit 4 in the Questionable Instrument Condition Register is set, i.e., changed from 0 to 1.

BIT NUMBER	<filter_setting> DECIMAL	THE FOLLOWING EVENTS, WHICH OCCURRED IN THE OUTPUT CHANNEL SPECIFIED BY <suffix>, ARE PASSED ON TO ITS OPERATION INSTRUMENT SUMMARY EVENT REGISTER:
0	1	OverVoltage Protection becomes active.
1	2	OverCurrent Protection becomes active.
4	16	Out of sense capability or overtemperature occurs.
8	256	Calibration data becomes invalid.
other		---------- Don't care ----------

Example:

Send → :STAT:QUES:INST:ISUM2:PTR 256

This will set bit 8 in the Questionable Instrument Summary Positive Transition Filter associated with Output Channel 2. Now when the calibration data of Output Channel 2 becomes invalid, this event will be propagated to the Questionable Instrument Summary 2 Event Register.

:STATus:QUEue[:NEXT]?

Action: Reports the next error message held in the instrument's error queue.

Query: :STATus:QUEue[:NEXT]?

Response: <error_number>,<error_message>

<error_number> This is an integer value in the range -32768 to 23767. The meaning of each error value that can be returned is described in Appendix F "Error Messages". If 0 (zero) is returned, there are no errors in the queue.

<error_message> This is a character sequence which briefly describes the error. When there are no errors in the queue, the error message will be "No error".

Description:

The error queue can hold errors that have occurred. These can be command or execution errors. The error queue is a "first-in first-out" queue. Therefore, the error query returns the oldest error. Once an error is read, it is removed from the queue, and the next error message is made available. When all the error messages have been read from the error queue, the message [0, "No error"] will be returned.

The error queue will be cleared after power-up, after a device reset, and when a *CLS command is received.

If there are more errors than the queue can hold, it will overflow. The oldest errors stay in the queue, but the most recent error is discarded and the latest error written in its place. When this happens, the last position in the queue contains a "Queue overflow" message.

This query is the equivalent of the :SYST:ERR? query.

Example:

Send → :STAT:QUE?
Read ← -222,"Data out of range"

:SYSTem:ERRor?

Action: Reports the next error message held in the instrument's error queue.

Query: :SYSTem:ERRor?

Response: <error_number>,<error_message>

<error_number> This is an integer value in the range -32768 to 23767. The meaning of each error value that can be returned is described in Appendix F "Error Messages". If 0 (zero) is returned, there are no errors in the queue.

<error_message> This is a character sequence that briefly describes the error. When there are no errors in the queue, the error message will be "No error".

Description:

The error queue can hold errors that have occurred. These can be command or execution errors. The error queue is a "first-in first-out" queue; therefore, the error query returns the oldest error. Once an error is read, it is removed from the queue, and the next error message is made available. When all the error messages have been read from the error queue, the message [0, "No error"] will be returned.

The error queue will be cleared after power-up, after a device reset, and when a *CLS command is received.

If there are more errors than the queue can hold, it will overflow. The oldest errors stay in the queue but the most recent error is discarded and the latest error is written in its place. When this happens, the last position in the queue contains a "Queue overflow" message.

Example:

Send → :SYST:ERR?
Read ← -222,"Data out of range"

:SYSTem:KLOCk

Action: Locks or unlocks the keyboard.

Command: :SYSTem:KLOCk <boolean>

<boolean> = 0 (=OFF) Keyboard unlocked.
1 (=ON) Keyboard locked.

The default setting after *RST is 0 (OFF).

Query: :SYSTem:KLOCk?

Response: <boolean>

Description:

The power supply will enter the remote state of operation as soon as a command or query is send. In this remote state the front panel keys cannot be used for settings. Only the LCL key can be used to return to the local state, i.e., use the keys again.

With this command the control of the keyboard can be enabled (unlocked) or disabled (locked) from being used locally. The state in which the keyboard cannot be used is called the 'local lockout' state. This state can be entered by sending the LLO-code (decimal 17) to the power supply. When the LCL key on the front panel is pressed in the 'local lockout' state, the power supply will remain in the remote mode of operation.

Pressing any key while the keyboard has been locked will cause the display to show the message KEYLOCK ON for a short time.

Note: The keyboard can be unlocked again by pressing the ENTER key for at least 5 seconds.

Example:

Send → :SYST:KLOC ON Only remote control possible, i.e., the keyboard has been locked.

.
.

Send → :SYST:KLOC OFF Local control can be obtained, i.e., the keyboard has been unlocked.

Press the LCL key to go into the local state of operation.

:SYSTem:POCLear

Action: Defines the 'Power On CLear" behavior of the power supply.

Command: :SYSTem:POCLear <boolean>

<boolean>	1 (=ON)	Sets the power supply in the STANDBY mode.
	0 (=OFF)	Sets the power supply in the mode that it was in at the moment of 'power off', i.e., the STANDBY or the OPERATE mode.

Query: :SYSTem:POCLear?

Response: <boolean>

Description:
This command is very useful to define the operating mode of your power supply in the case of power loss. So when your power supply recovers after a period of no power, it will continue in the STANDBY mode or in the mode that it was in just before the power off happened.
After the *RST command, the mode becomes STANDBY.

Example:

Send →	*RST	Mode becomes STANDBY.
Send →	:INST:STAT?	
Read ←	1	Operating mode = STANDBY.
Send →	:INST:STAT ON	Power supply enters the OPERATE mode.
Send →	:SYST:POCL OFF	'Power on Clear' mode becomes OPERATE mode.
Switch off the power supply.		
.		
Switch on the power supply.		Operating mode becomes OPERATE.

:SYSTem:SET

Action: Sets the instrument functions, using the block_data, which was previously retrieved by the :SYSTem:SET? query.

Command: :SYSTem:SET <block_data>

<block_data> = <arbitrary_block_program_data>

This equals the following:
#<number><lenght><8-bit databytes>
where,

<number> =	The number of digits in <length>.
<lenght> =	The number of 8-bit databytes that follow.
<8-bit databytes> =	A sequence of 8-bit bytes in the range 00 to FF (or 0 to 255 decimal). Be aware that these bytes can be unprintable characters.

Query: :SYSTem:SET?

Response: <block_data>

Description:
This command quickly sets all programmable functions, using the definite-length <arbitrary block response data> previously retrieved with the :SYSTem:SET? query. It is the functional equivalent of the common command *RCL, except that the data is not saved in the memory of the power supply, but in the memory of the GPIB controller.

Example:
Send → :SYST:SET?
Read ← <settings>
.
.
Send → :SYST:SET <settings>

:SYSTem:UNPRotect:PWORd

Action: Defines a new password to the optional handle.

Command: :SYSTem:UNPRotect:PWORd <password> [,<handle>]

<password> 4-Digit admission code;
Default = number in type-number, e.g., 2831.

<handle> Option handle to be selected;
CAL(ibration) is the only available option.

Description:

Before a new password is accepted, the following must be unprotected:

- Send → :SYST:UNPR ON Enables to unprotect calibration.
- Send → :SYST:UNPR:SEL <pw> Unprotects the calibration by sending the password <pw>.

If the password was not correct, error code -221 (Settings conflict) will be generated. This error can be read using the :SYST:ERR? query.

Example:

For a PM2831 power supply with the default calibration password.

Send → :SYST:UNPR ON Enables to unprotect calibration.
Send → :SYST:UNPR:SEL 2831 Unprotects the calibration of the power supply by sending the password as calibration access code; default = 2831.

Send → :SYST:ERR?
Read ← <error>
IF <error> = -221 THEN print "password not correct" STOP
Send → :SYST:UNPR:PWOR 1234
The calibration password has been changed from 2831 to 1234.

Note: Please write down your (new) calibration code. If you forgot your calibration code, refer to chapter 2 "MAINTENANCE".

:SYSTem:UNPRotect:SELect

Action: Selects a handle to become unprotected.

Command: :SYSTem:UNPRotect:SELect <password>[,<handle>]

<password>	4-Digit admission code; Default = number in type-number, e.g., 2831 for the PM2831 power supply.
<handle>	Option handle to be selected; CAL(ibration) is the only available handle option.

Query: :SYSTem:UNPRotect:SELect?

Response: <handle>

Description:

With this command a handle can be selected, which is to be excluded from protection, i.e., becomes unprotected. After the command :SYST:UNPRotect[:STATe] ON, the selected handle becomes unprotected. After the command :SYSTem:UNPRotect[:STATe] OFF, all handles become protected again.

Example:

For a PM2831 power supply with the default calibration password.

Send →	:SYST:UNPR ON	Enables to unprotect calibration.
Send →	:SYST:UNPR:SEL 2831	Unprotects the calibration of the power supply by sending the password as calibration access code; default = 2831.

Send → :SYST:ERR?
Read ← <error>
IF <error> = -221 THEN print "Password not correct" STOP
.
Perform calibration for a selected output channel.
.

:SYSTem:UNPRotect[:STATe]

Action: Enables (protects) or disables (unprotects) the selection of handles.

Command: :SYSTem:UNPRotect[:STATe] <boolean>

<boolean>	1 (=ON)	Unprotects the selection of handles.
	0 (=OFF)	Protects the selection of handles.

Query: :SYSTem:UNPRotect[:STATe]?

Response: <boolean>

Description:
Before a password can be changed or a handle can be selected, they have to be unprotected. After changing of the password and/or calibration of an output channel, the selection of handles must be protected again.

Example:
For a PM2831 power supply with the default calibration password.

Send →	:SYST:UNPR ON	Enables to unprotect calibration.
Send →	:SYST:UNPR:SEL 2831	Unprotects the calibration of the power supply by sending the password as calibration access code; default = 2831.

.
Perform the calibration of the PM2831 output channel
.

Send →	:OUTP:STAT OFF	Disables the selected output channel.
Send →	:SYST:UNPR OFF	Disables the unprotection of the calibration, i.e., the next calibration is protected again.

:SYSTem:VERSion

Action: Selects the version of the SCPI command set that your programmable power supply complies to.

Command: :SYSTem:VERSion <float>

<float> = Floating point value.

Query: :SYSTem:VERSion?

Response: <float>

Description:
This command selects the version of the SCPI command set, according to which version the power supply will respond. The floating-point value will be rounded to xxxx.y, e.g., 1993.0.

Example:
Send → :SYST:VERS 1993.0 Selects the 1993.0 SCPI version.

:TEST:INSTrument?

Action: Performs the self-test of the selected output channel and reports the test result.

Query: :TEST:INSTrument?

Response: <test_result>

<test_result>	0 | <integer>
0	No error has occurred during the self-test.
<integer>	Errorcode, which indicates the first error that occurred during the self-test of the selected output channel.

Description:
For possible error codes, refer to Appendix D "Error Messages".

Example:

```
Send →  :TEST:INST?
Read ←  <result>
Send →  :INST:NSEL?          Requests the selected channel number.
Read ←  <chan>
IF <result> # 0 THEN
Print "error during channel "; <chan>; " test: ", <result>
```

:TEST:SYSTem?

Action: Reports the test results of the power-on self-tests.

Query: :TEST:SYSTem?

Response: <test_result>

<test_result> =	0 | <integer>
0	No error has occurred during the self-tests.
<integer>	Errorcode, which indicates the first error that occurred during the self-tests of the power supply.

Description:
This query is equivalent to the *TST? query. For possible error codes, refer to Appendix D "Error Messages".

Example:
Send → :TEST:SYST?
Read ← <result>
IF <result> # 0 THEN print "error during self-test: ", <result>

2 MAINTENANCE INSTRUCTIONS

2.1 INTRODUCTION

This section describes how to maintain your programmable power supply. A distinction has been made between preventive maintenance and corrective maintenance.

Preventive maintenance applies to those measures that prevent your instrument from becoming less accurate. It is recommended that you repeat section 2.2.1 "Performance verification checking" once a year for each of the output channels of your programmable power supply.

Corrective maintenance applies to those measures that correct your instrument after errors or inaccuracies have occurred. The following corrective measures are described:

- Troubleshooting; refer to section 2.3.1 for the following:
  - Handling an Overcurrent situation.
  - Handling an Overvoltage situation.
  - Dealing with an unknown (forgotten) calibration code.
  - Handling an unregulated output channel situation.
  - Handling a FAIL situation.
  - Dealing with an error during testing.
- Replacing the fuses; refer to section 2.3.2.1.
- Calibration of your instrument; refer to section 2.3.3.

2.2 PREVENTIVE MAINTENANCE

2.2.1 Performance verification checking

This section describes how you can verify the performance of your power supply, i.e., check its performance against the performance specifications in Appendix A "Technical Specifications". Performance verification checking is done manually, using the keys and a connected multimeter. Before any check can be done, the power supply must warm up for 30 minutes.

Notes:
- *All limits and tolerances in this section are calibration guidelines. They should not be interpreted as instrument specifications.*
- *The tolerances mentioned are the tolerances for the power supply and do not include errors of the test equipment.*

As test equipment, a meter for measuring voltage and current must be connected to the output channel under verification. The measured voltage and current will be used as reference values.

The complete PERFORMANCE VERIFICATION PROCEDURE is given in Appendix B.

If some voltage or current inaccuracies were found during performance verification checking, your power supply must be calibrated again. Refer to section 2.3.3 "Calibration" for full information.

2.3 CORRECTIVE MAINTENANCE

2.3.1 Troubleshooting

2.3.1.1 Overcurrent situation

A selected output channel of your power supply can be in overcurrent for one of the following reasons:

- The programmed (maximum) current level is lower than the actual load current and the OverCurrent Protection (OCP) circuitry has been enabled.
  Solution:
  Check whether the actual current is in the expected range with respect to the load conditions. Also check the connections between load and output channel. If allowed, program the overcurrent level higher than the current through the load or check to make sure that the programmed output voltage is not too high. Reset the OCP circuitry of the selected output channel by pressing the RESET key.

- Another output channel is in overcurrent, and protection coupling has been enabled.
  Solution:
  Remove the cause of the OCP in the coupled output channel, and reset the coupled output channel by pressing the RESET key. If allowed, remove the coupling of the OCP mechanisms of the output channel(s) involved.

2.3.1.2 Overvoltage situation

A selected output channel of your power supply can be in overvoltage for one of the following reasons:

- The programmed overvoltage level is lower than the programmed voltage level.
  Solution:
  Check whether the actual current is in the expected range with respect to the load conditions. Also check the connections between load and output channel. If allowed, program the overvoltage level higher than the voltage level. Reset the Over Voltage Protection (OVP) circuitry of the selected output channel by pressing the RESET key.

- Another output channel is in overvoltage, and protection coupling has been enabled.
  Solution:
  Remove the cause of the OVP in the coupled output channel and reset the coupled output channel by pressing the RESET key. If allowed, remove the coupling of the OVP mechanisms of the output channel(s) involved.

2.3.1.3 Unknown Calibration Code

If you forgot your calibration access code, you must take the following steps to restore the default code:

STEP 1) Turn the power off, and remove all connections at the rear.

STEP 2) Remove the cover from the power supply by removing the following screws:
- the 2 screws on the left near the front (only for multiple output units)
- the 2 screws on the right near the front (only for multiple output units)
- the screw in the left and right stand-up feet at the rear
- the screw at the bottom (near the rear)

Slide the cover backwards off the power supply.

WARNING: Removing the instrument cover is likely to expose live parts and accessible terminals, which can be dangerous to life. Capacitors inside the instrument can hold their charge, even if the supply has been separated from all voltage sources.

CAUTION: Do not touch any components on the printed circuit board inside the power supply. This is to prevent electrostatic discharge which may damage electrical components.

STEP 3) Restore the default calibration code as follows:
First turn the instrument over. On the CPU board on the underside of the instrument, find the white pushbutton next to the microprocessor (the square chip). Press this button for about 5 seconds while turning on the line power. Now the default calibration access code will be restored. The default code is the number (four figures) of your type number, e.g., 2831. Turn off the power again.

STEP 4) Move the power supply back into its cover. Reinsert the screws and tighten them.

2.3.1.4 Unregulated output situation

The power supply informs you when output regulation is not guaranteed. This can occur when operating with output channels in parallel at relatively low output currents.

Solution:

Switch over to one output channel or program a higher output current.

2.3.1.5 FAIL situation

The cause for a FAIL indication in the status can be Overtemperature or out of Sense Capability.

In case of out of Sense Capability, check the load lead resistance
It is advised to use short leads with low resistance.

In case of Overtemperature, turn the power off and wait until the power supply has reached a safe operating temperature, i.e., the release temperature. The overtemperature protection is at 90°C ± 5°C for PM2811/12/13 and 95°C ± 5°C for PM2831/32. The release temperature is at 60°C ± 5°C.

2.3.1.6 Error during testing

If one of the self-tests fails, try it again by switching the power off and on again. If one of the self-tests fails again, write down the specific error message, and contact your local FLUKE Service or Sales Center. A list of these centers is printed at the back of this manual.

If a performance check fails for an output channel, perform the calibration of that output channel. Refer to section 2.3.3."Calibration".

If a GPIB interface check fails, check that the following interface parts are working correctly:

- GPIB interface card in the controller
- GPIB interface cable
- GPIB software drivers in combination with the programming environment

If no errors can be found, contact your local FLUKE Service or Sales Center. A list of these centers is printed at the back of this manual.

2.3.2 Replacements

2.3.2.1 Replacing a Fuse

WARNING: When a fuse must be replaced, the instrument must be switched off and disconnected from the line power to prevent shock.

The power input module is located at the rear of the power supply. This module contains the input socket, the power filter (left side), the fuse (in the middle) and the power switch (right side). The fuse can be pulled out and pushed aside. In this way the two fuses will become visible. Replace those fuses by the two spare ones, which are supplied at delivery. Finally restore the situation as it was before the replacement.

2.3.3 Calibration

This section describes how to calibrate your programmable power supply. It is recommended that you calibrate each of the output channels once a year. There are two ways to perform the calibration:

1) Locally using the front panel keys

2) Remotely by sending commands and queries via a GPIB controller

Those two ways cannot be combined. When calibration is done via the front panel keys, the first command via the GPIB automatically terminates the calibration session. When calibration is done via a GPIB controller, it terminates automatically as soon as the LCL key is pressed.

Before the actual calibration mode can be entered, the CAL access code must be entered. If the correct code is entered, the calibration mode will be active. If the CAL access code has been forgotten, refer to section 2.3.1.3 "Unknown calibration code".

Calibration is done for one output channel at a time. New calibration data is made active when the calibration session is terminated correctly. To perform a complete calibration of your power supply, you need a multimeter (with sufficient accuracy and resolution) connected to the output channel.

Note: Because the voltage and current to be measured with the DMM will be used as the reference for the calibration voltage and current, the DMM itself must have been calibrated accurately.

2.3.3.1 Calibration Procedure

You can calibrate the power supply via the front panel keys (local control) or via the GPIB (remote control). The complete Calibration Procedure is given in Appendix C. For this procedure, the local as well as the remote sequence is given. The local sequence deals with the keys that you must press; the remote sequence gives the equivalent remote commands. The list of remote commands does not form a complete GPIB program but should be considered as a help for writing a complete program. For further details, refer to Appendix C.

APPENDIX A
TECHNICAL SPECIFICATIONS

A.1 CHARACTERISTICS OF THE POWER SUPPLIES

A.1.1 Performance Characteristics

A.1.1.1 Instrument Specifications

environmental aspects:	meets requirements of MIL-T 28800D (type III, class 5, style E)		
temperature in °C		**relative humidity in %**	
non-operating[1)]	operating[2)]	non-operating[1)]	operating[2)]
-40 to 71[3)]	0 to 30	95 ± 5	95 ± 5
	31 to 40	95 ± 5	75 ± 5
	41 to 50	95 ± 5	45 ± 5

1) Non-operating limits relate to absorbtion and corrosion effects.
2) Operating limits relate to actual operating conditions.
3) For the LCD the range is from -20 to 71.

altitude	
non-operating:	4500 m (15000 ft)
operating:	3050 m (10000 ft)
vibration, sinusoidal	
frequency	5 ... 55 Hz
resonance search	15 minutes per axis
cycling	15 minutes per axis
resonance dwell	10 minutes per axis
gravity level at max. frequency	2g m/s^2 at 55 Hz
shock, functional	
peak accelleration	20g m/s^2
amount of shocks	18, 3 in each direction (x, y and z)
shock wave form	half sine wave
duration	11 ms
bounce, loose cargo **bench handling** **shock, high impact**	conform to MIL-T 28800D

reference temperature:	23 ± 2°C (for performance test + calibration)
overtemperature (of the power modules)	
protection:	90 °C ± 5 °C for PM2811/12/13
	95 °C ± 5 °C for PMPM2831/32
release at:	60 °C ± 5 °C
isolation:	output terminals may not be more than 240V from ground (output voltage included)
display update rate (measured results)	
normal mode:	4x / sec.
load cross regulation:	negligible for voltage and current

A.1.1.2 Output Module Specifications

OUTPUT PM2811/12/13

	30V/10A/60W	60V/5A/60W	60V/10A/120W
Ranges			
Output voltage range	0 to 30V	0 to 60V	0 to 60V
Output current range	0 to 10A	0 to 5A	0 to 10A
Output power	max. 60W	max. 60W	max. 120W
Overvoltage protection range	2 to 32V	2 to 62V	2 to 62V
Output accuracy			
Output voltage	± (0.04% + 10 mV)	± (0.04% + 20 mV)	± (0.04% + 20 mV)
Output current	± (0.10% + 50 mA)	± (0.10% + 25 mA)	± (0.10% + 50 mA)
Overvoltage protection	± (0.50% + 150 mV)	± (0.50% + 250 mV)	± (0.50% + 250 mV)
Temperature coëfficient			
Output voltage	(0.016% + 2 mV)/K	(0.016% + 2 mV)/K	(0.016% + 2 mV)/K
Output current	(0.05% + 2 mA)/ K	(0.05% + 2 mA)/ K	(0.05% + 2 mA)/ K
Long term drift (8 hour period)			
Output voltage	0.04% + 5 mV	0.04% + 5 mV	0.04% + 5 mV
Output current	0.05% + 10 mA	0.05% + 10 mA	0.05% + 10 mA
Programming resolution (12 bit)			
Output voltage	7.5 mV/lsb	15 mV/lsb	15 mV/lsb
Output current	2.5 mA/lsb	1.25 mA/lsb	2.5mA/lsb
Overvoltage protection	7.5 mV/lsb	15 mV/lsb	15 mV/lsb
Source effect (for any line voltage change within rating)			
Voltage	± (0.01% + 2 mV)	± (0.01% + 2 mV)	± (0.01% + 2 mV)
Current	± (0.02% + 2 mA)	± (0.02% + 2 mA)	± (0.02% + 2 mA)
Load effect (load change 10% to 90% or 90% to 10% full load)			
Constant voltage	± (0.01% + 5 mV)	± (0.01% + 5 mV)	± (0.01% + 5 mV)
Constant Current	± (0.02% + 5 mA)	± (0.02% + 5 mA)	± (0.02% + 5 mA)
Output noise (PARD)			
Constant voltage			
rms	3V	6V	6V
peak-to-peak (40 Hz to 30 MHz)	15 mV	30 mV	30 mV
Constant current			
rms	10 mA	10 mA	10 mA
Switching frequency	±20 kHz	±20 kHz	±20 kHz

READBACK PM2811/12/13

	30V/10A/60W	60V/5A/60W	60V/10A/120W
Readback accuracy			
Voltage accuracy	± (0.05% + 25 mV)	±(0.05% + 50 mV)	± (0.06% + 50 mV)
Current accuracy	± (0.1% + 30 mA)	± (0.1% + 15 mA)	± (0.2% + 30 mA)
Measuring resolution (12 bit)			
Voltage resolution to interface	7.5 mV	15 mV	15 mV
Current resolution to interface	2.5 mA	1.25 mA	2.5 mA
Voltage resolution to display	10 mV	10 mV	10 mV
Current resolution to display	10 mA	10 mA	10 mA

SUPPLEMENT CHARACTERISTICS PM2811/12/13

	30V/10A/60W	60V/5A/60W	60V/10A/120W
Reverse voltage	max. current 10A	max. current 5A	max. current 10A
Remote sense capability Minimum allowable voltage drop per load lead *NOTE: at open sence connections, the output voltage will be not more than 3V above the programmed value.*	0.25V	0.25V	0.25V
Dynamic behaviour			
Load variation	1A between 1A and 10A	0.5A between 0.5A and 5A	1A between 1A and 10A
Settling band	±50 mV	±50 mV	±50 mV
dI/dt	1 A/µs	0.5 A/µs	1 A/µs
Overshoot	150 mV	150 mV	150 mV
Recovery time	1 ms	2 ms	2 ms
Programming response time			
Settling band	50 mV	50 mV	50 mV
Trise (0V to max. volt)	100 ms @ 2A	200 ms @ 1A	100 ms @ 2A
Trise (0V to max. volt)	50 ms @ no load	100 ms @ no load	50 ms @ no load
Tfall (max. volt to 1V)	100 ms @2A	200 ms @ 1A	100 ms @ 2A
Tfall (max. volt to 1V)	250 ms @ no load	500 ms @ no load	250 ms @ no load
Reprogramming delay			
Range	50 ms to 60s	100 ms to 60s	100 ms to 60s
Resolution	1 ms	1 ms	1 ms
Default	50 ms	100 ms	100 ms
Step interval time	up to 60 s	up to 60 s	up to 60 s

A.1.1.3 Output Module Specifications

OUTPUT PM2831/32

	8V-15A-120W	60V-2A-120W	120V-1A-120W
Ranges			
Output voltage range	0V to 8V	0V to 60V	0V to 120V
Output current range *) at 40 °C	-15A to +15A	-2A to +2A	-1A to +1A
at 45 °C	-15A to +12.5A	-2A to +2A	-1A to +1A
at 50 °C	-15A to +10A	-2A to +2A	-1A to +1A
Output power	120W	120W	120W
Overvoltage protection range	0V to 10V	0V to 62V	0V to 122V
*) Minimum output voltage at maximum sink current:	1.0V	1.5V	1.5V
Output accuracy			
Output voltage	0.04% + 4 mV	0.04% + 15 mV	0.04% + 30 mV
Output current (+ and -)	0.24% + 8 mA	0.04% + 0.5 mA	0.04% + 0.25 mA
Overvoltage protection	0.04% + 4 mV	0.04% + 15 mV	0.04% + 30 mV
Temperature coëfficient			
Output voltage	0.01% /K	0.01% /K	0.01% /K
Output current	0.01% /K	0.01% /K	0.01% /K
Long term drift (8 hour period)			
Output voltage	0.02%	0.02%	0.02%
Output current	0.02%	0.02%	0.02%
Progr. resolution (12 bit)			
Output voltage	2 mV	15 mV	30 mV
Output current	3.75 mA	0.5 mA	0.25 mA
Overvoltage protection	2.5 mV	15.5 mV	30.5 mV
Source effect (for any line voltage change within rating)			
Voltage	1 mV	2 mV	2 mV
Current	4 mA	1 mA	0.5 mA
Load effect (load change 10% to 90% or 90% to 10% of full load)			
Constant voltage	1 mV	2 mV	2 mV
Constant current	4 mA	1 mA	0.5 mA
Output noise (PARD)			
Constant voltage			
rms	1 mV	1 mV	1 mV
peak-to-peak (20 Hz to 20 MHz)	4 mV	6 mV	6 mV
Constant current			
rms	15 mA	2 mA	2 mA

READBACK PM2831/32

		8V-15A-120W	60V-2A-120W	120V-1A-120W
Readback accuracy				
Voltage		0.05% + 4 mV	0.05% + 15 mV	0.05% + 30 mV
Output current (+ and -)		0.05% + 8 mA	0.05% + 1 mA	0.05% + 0.5 mA
Measuring resolution (12 bit)				
Voltage		2 mV	15 mV	30 mV
Current		3.75 mA	0.5 mA	0.25 mA
Display format (see Notes)				
Voltage		dd.ddV	dd.ddV	ddd.ddV
Current	<10A	Sd.dddA	Sd.dddA	Sd.dddA
	≥10A	Sdd.ddA	-	-
GPIB format (see Notes)				
Voltage		dd.ddd	dd.dd	ddd.dd
Current		Sdd.ddd	Sd.dddd	Sd.dddd

Notes *d = digit* *Leading zeros are blanked on the display*
Leading zeros are omitted for output to the GPIB

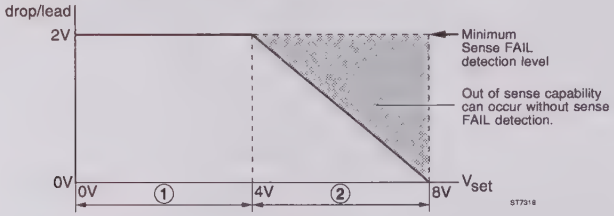
S = sign *The +sign is blanked on the display*
The +sign is omitted for output to the GPIB

Voltage
Current *The specified format is valid for the settings returned for Voltage, Overvoltage, and Current and is also valid for the actual values read back.*

SUPPLEMENTAL CHARACTERISTICS PM2831/32

	8V-15A-120W	60V-2A-120W	120V-1A-120W
Reverse Voltage	max. current 15A	max. current 2A	max. current 0.5A
Remote sense capability Minimum allowable voltage drop per load lead	2V if $V_{set} \leq 4V$ $\frac{8V\text{-}V_{set}}{2}$ if $V_{set} > 4V$ (see Note next page)	1V	1V
Dynamic behavior			
Load transient response Load change 50% of maximum	$\Delta I = 7.5A$	$\Delta I = 1A$	$\Delta I = 0.5A$
Settling band	8 mV	60 mV	120 mV
Overshoot (di/dt = 5A/µs)	100 mV	100 mV	100 mV
Recovery time	100 µs	100 µs	100 µs
Programming response time			
Trise, Tfall no load	500 µs	500 µs	500 µs
with load (50%)	1 ms @7.5A	1 ms @1A	1 ms @0.5A
Maximum overshoot	300 mV	300 mV	300 mV
Rise and fall times (Trise/Tfall) are the maximum time for the output to change from 10% to 90%, or from 90% to 10% of its total excursion.			
Source/sink			
Switching time	1 ms	1 ms	1 ms
Source to sink level	0.6V	0.6V	0.6V
Hysteresis	150 mV	150 mV	150 mV
Reprogramming delay			
Range	0 ms to 60 s	0 ms to 60 s	0 ms to 60 s
Resolution	1 ms	1 ms	1 ms
Default	1 ms	1 ms	1 ms
Step interval time	up to 60 s	up to 60 s	up to 60 s

Note: The formula indicates that the remote sense capability decreases when V_{load} rises above 4V (see the following diagram).



① *Full sense capability. Out of sense capability (drop >2V per load lead) will cause sense FAIL detection, so that this protection sets the output to 0V and 0A.*

② *Declining sense capability. Out of sense capability can occur without sense FAIL detection, though the drop per load lead remains under 2V (shaded area). A ripple may then appear on the load voltage as the sense capability may be not sufficient to compensate for the voltage drop accross the load leads, especially under worst case conditions such as minimum line power voltage and maximum load current*

A.1.2 Safety characteristics

The instrument has been designed and tested in accordance with IEC Publication 1010 and has been supplied in a safe condition. The present Operation Manual contains information and WARNING or CAUTION statements, which must be followed by the purchaser to ensure safe operation and to keep the instrument in a safe condition.

safety :
- meets requirements of IEC 1010, UL 1244 and VDE 0411
- approved according to CSA 22.2 nr. 231
- the power cord meets the requirements of:
  - VDE 0411 if shipped with universal European power plug
  - UL 1244/CSA 22.2 if shipped with North American power plug

Protective circuitry within the power supply limits or turns off an output channel in the event of an abnormal condition. The activated protection feature can be observed on the front panel display area. You can also read back the status of the power supply via the GPIB.

The following protection features have been implemented:

OVERVOLTAGE

Disables the output channel by reducing the output to zero volts and zero amperes if the output voltage exceeds the programmed overvoltage. When an overvoltage occurs, the text OVERVOLTAGE appears on the display and the OV status bit is set for that output channel.

OVERCURRENT

Disables the output channel by reducing the output to zero volts and zero amperes if the overcurrent protection (OCP) has been enabled and the output current exceeds the maximum current level. In this case the text OVERCURRENT appears on the display and the OC status bit is set for that output channel.

UNREGULATED OUTPUT

The power supply informs the user when an output regulation is not guaranteed. In this case the UNR status bit is set for the unregulated output channel.

OVERTEMPERATURE

Disables the output channel, which has reached an unsafe internal operating temperature, by reducing the output to zero volts and zero amperes. This can be caused by:

- an excessively high ambient temperature
- a blocked or defective fan
- inadequate air circulation, because of insufficient side space

Refer to the protection and release temperature in table A.1.1.1. The overtemperature protection is activated when the overtemperature is exceeded. The overtemperature protection will be released when the temperature is lower than the release temperature and if the protection circuitry is reset.

FAULT

The annunciator above the text FLT is displayed, if the output channel is in a status event, which has been unmasked, so that it will be reported. The following power supply status events have been defined:

- CP = coupled parameters have been applied
- UNR = output is unregulated
- FL = output channel is in overtemperature or out of sense capability
- OC = output channel is in overcurrent
- OV = output channel is in overvoltage
- CC = output channel is in constant current mode
- CV = output channel is in constant voltage mode

A.1.3 Dimensions and weight

	PM2811	PM2812/13/31/32
Dimensions:		
height	±2U = 86 mm	±2U = 86 mm
width	½ x 19 inch = 210 mm	19 inch = 420 mm
depth	370 mm	370 mm
Net Weight:		
PM2811	±5.5 kg	
PM2812		±9.5 kg
PM2813		±9.5 kg
PM2831		±10 kg
PM2832		±14 kg

A.1.4 Line power input conditions

Power input:	230V ± 10% 115V ± 10%				
Power frequency:	47 Hz to 63 Hz				
	PM2811	PM2812	PM2813	PM2831	PM2832
Fuses 2x 115V	2.5 AT	4 AT	6.3 AT	3 AT	6.3 AM
230V	1.25 AT	2.5 AT	3 AT	1.6 AT	3 AT
Power consumption	155 VA	275 VA	390 VA	275 VA	550 VA
Peak inrush current	**60A**				

A.2 INTERFERENCES

A.2.1 Electromagnetic Compatibility (EMC)

Emission	: meets requirements of VDE0871B + CISPR 11
Susceptability	: meets requirements IEC 801 1-6
Electrostatic Discharge (ESD)	: meets requirements IEC 801-2
CE	: meets requirements of EN50081-1: Emissions EN55022 Radiated Emissions EN50082 Conducted : meets requirements of EN50082-1: IEC 801-2, 3, 4, 5

A.2.2 Radio Frequency interference

The RFI for an output channel meets the requirements of VDE 0871/A.

A.3 GENERAL PURPOSE INTERFACE BUS

A.3.1 Interface specification

The pin numbering and signal assignment conforms to the IEEE-488.2 1987 standard.

Pin nr.:	Signal:	Pin nr.:	Signal:
1	DIO 1	13	DIO 5
2	DIO 2	14	DIO 6
3	DIO 3	15	DIO 7
4	DIO 4	16	DIO 8
5	EOI	17	REN
6	DAV	18	GND 6
7	NRFD	19	GND 7
8	NDAC	20	GND 8
9	IFC	21	GND 9
10	SRQ	22	GND 10
11	ATN	23	GND 11
12	SHIELD	24	LOGIC GND

Notes:
- *DIO = Digital Input Output lines*
- *EOI = End Or Identify*
- *REN = Remote ENable*
- *DAV = DAta Valid*
- *GND = GrouND*
- *NRFD = Not Ready For Data*
- *NDAC = Not Data ACcepted*
- *IFC = InterFace Clear*
- *SRQ = Service ReQuest*
- *ATN = ATtentioN*

A.3.2 Function specification

Interface function	Ident. code	Description
Source handshake	SH1	Complete capability
Acceptor handshake	AH1	Complete capability
Talker function	T5	• Basic talker • Serial Poll • Talk only • Unaddress if MLA
Listener function	L3	• Basic listener • Listen only • Unaddress if MTA
Service request	SR1	Complete capability
Remote local	RL1	Complete capability
Parallel poll	PP0	No capability
Device clear	DC1	Complete capability
Device trigger	DT1	Complete capability
Controller	C0	No capability

Notes: - MLA = My Listen Address
- MTA = My talk Address

Electrical specifications:

Characteristics	Specification	Additional information
• Bus drivers	E2	low = 0 to 0.8V high = 2 to 5V
• GPIB address	0 to 30	Can be set with the AUX key
(default)	28	At delivery

A.4 TRIGGER BUS

A.4.1 Function specification

The trigger bus, located at the rear of the power supply, consists of three SMB connectors, i.e.:

- the START input line
- the STEP input line
- the READY output line

Note: low = 0 to 0.8 V and high = 2 to 5 V

The trigger bus can be operated in 2 ways:

1) In the synchronous mode:
   In this mode all 3 bus signal lines have their own functionality.
2) In the asynchronous mode:
   In this mode the READY line is externally connected to the START line.

The trigger bus can be used to control the internal recall memory. A recall memory consists of 999 addresses, numbered from 1 to 999. A recall memory address contains space for the voltage and current setting of all available output channels.

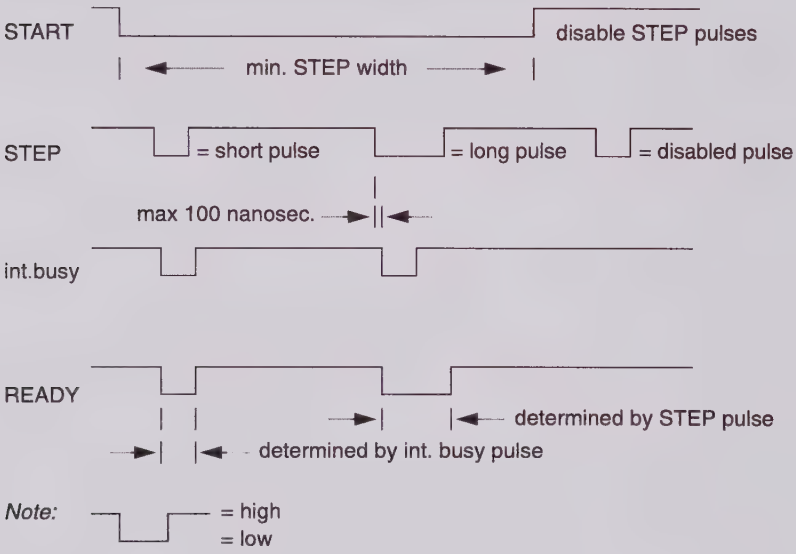
To control the recall memory via the trigger bus, the STEP mode may not be automatic and the START input line must be pulled low. This will enable the STEP line to trigger the next step to be executed (external triggering). Pulling the START line low will also disable the manual STEP key.

A.4.2 Timing

When enabled a STEP pulse will trigger the step mechanism. The leading edge of the STEP pulse makes the READY line active (low) within 100 nanoseconds. The READY line will be released when the internal processing is finished and the STEP line is high. Not included is the reprogramming delay time. It is the responsibility of the user to choose a STEP rate. This STEP rate may not be too high, so that the output cannot settle within the resulting STEP time.

Note: STEP pulses, received while the READY line is low, will be ignored.

The following scheme shows the timing relationship:



APPENDIX B
PM28xx PERFORMANCE VERIFICATION

WARNING: Before switching-on, ensure that the power supply has been installed in accordance with the Installation Instructions, outlined in Section 3 of the Users Manual, to prevent shock or instrument damage.

It is assumed that the power supply passed the Acceptance Tests given in Section 3.6 of the Users Manual.

The Performance Verification procedure is intended for the following purposes:

- To check the specifications of the power supply.
- For incoming inspection to determine the acceptability of newly purchased power supplies and/or recently recalibrated power supplies.
- To check the necessity of recalibration.

Note: The procedure does not check every facet of the power supply's calibration; rather, it is concerned primarily with those parts of the power supply which are essential to correct operation and readback. Removing the power supply's cover is not necessary to perform this procedure. All tests are made from the outside of the power supply.

If the procedure is started within a short period after switching-on, bear in mind that the steps may be out of specification, due to insufficient warming-up time.

Warming-up time under average conditions is 30 minutes.

RECOMMENDED TEST EQUIPMENT

EQUIPMENT	REQUIRED SPECIFICATION
Digital Multimeter (DMM): Fluke 8840 or PM2534	DC voltage accuracy 0.01%
Shunt: Guildline Model 9230/15 (0.1Ω) for I<3A Guildline Model 9230/100 (0.01Ω) for I>3A	Accuracy 0.01% *(see the Note).*
DC Power Supply: PM2811/4	Ouput range: 0V to 30V, 0A to 30A.

Note: To achieve the required accuracy, the shunt must be calibrated to use it as a transfer standard.

CONVENTIONS FOR THE FOLLOWING TABLES

- Values marked xxxx are not relevant and need not to be verified.
- [V] [1] [ENTER] This is an example of a key sequence. It means that you must press the indicated keys in the order from left to right.
- CV = Constant Voltage annunciator; CC = Constant Current annunciator.
- If CV or CC is given in the following tables, this annunciator must be displayed. If it is not displayed, check if the wiring to the PPS terminals and to the DDM inputs is correct, if the correct output channel is selected, and if the DMM is set to the correct measuring function.
- Along with each key sequence, the equivalent remote command string is also given. This helps you to write your own remote controlled verification procedure. Refer to the user manuals of your GPIB controller for information about remote control of GPIB devices. Refer to the user manuals of the DMM for information about how to program the DMM functions and how to read out the DMM measurement results.
- On the left margin you will find a number, which refers to extended descriptions at the back of this Appendix.

NOTES TO THE VALUES GIVEN IN THE FOLLOWING TABLES

- Tolerances given are for the power supply under test and do not include test equipment errors.

- DMM readout not within limits.

  The DMM readout must be within the specified limits. If the DMM readout is outside these limits, the power supply should be calibrated; use the Calibration Procedure in Appendix C.

- Readback via remote (GPIB) or via the PM28xx display.

  The readback accuracies are specified for readback via the GPIB. This provides the maximum readback accuracy. The readback values on the PM28xx display are truncated in correspondence with the resolution of 10 mV for voltages and 1 mA for currents.

- Readback not within limits.

  The readback value shown on the power supply's display may deviate a specified value from the actual output parameter (DMM readout). If the DMM readout is correct but the corresponding readback value is outside the specified limits, the power supply is defective and should be repaired; contact your local Fluke representative. Addresses are given at the back of this manual.

REQUIRED SETTINGS

Before starting a verification procedure, the following settings are required:

1. Wanted channel selected.
2. Output set to 0V, 0A.
3. Overvoltage protection set to the maximum trip level.
4. Overcurrent protection disabled.
5. Output enabled.
6. Operate mode set.

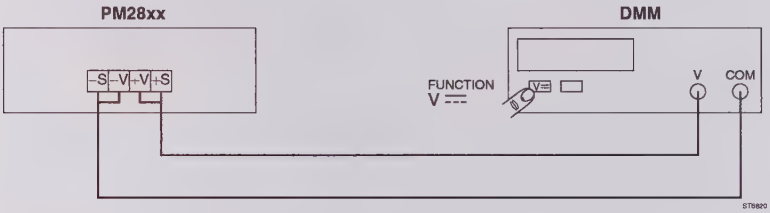
The following table shows when you must change a setting (under the header APPLICABLE CONDITION) and how you can do this.

TABLE B-1

	APPLICABLE CONDITION	PRESS KEY	EQUIVALENT REMOTE COMMAND	DESCRIPTION
1	The next output channel must be verified.	SELECT Skip for PM2811, PM2831	:INST:NSEL <n>	This selects output channel <n>.
2	Always	V 0 ENTER V 4 ENTER	:VOLT 0 :CURR 0	Output set to 0V, 0A.
3	Overvoltage Protection not at maximum trip level.	OVP <maximum>	:VOLT:PROT MAX	This sets the Overvoltage Protection level to maximum.
4	Overcurrent Protection is enabled.	OCP EN OCP DIS	:CURR:PROT:STAT OFF	This disables Overcurrent Protection
5	The display for the selected output channel shows DISABLED.	ENABLE DISABLE Skip for PM2811, PM2831	:OUTP ON	This enables the selected output channel.
6	The power supply is in STANDBY mode.	OPR STBY	:INST:STAT ON	This places the power supply in OPERATE mode.

Now you can do one of the following verification procedures.

OUTPUT VOLTAGE VERIFICATION



Requirements: No load connected
PM28xx must be in CV (Constand Voltage mode).

8V/15A/120W OUTPUT

	ACTION / KEY STROKES	EQUIVALENT REMOTE CMD	OUTPUT ACCURACY (DMM readout)	READBACK ACCURACY (display resolution 10 mV)	
7	I 5 ENTER	:CURR 5	xxxxxV	x.xx V	xx
8	V 1 ENTER	:VOLT 1	1V ± 3.4 mV	DMM ± 4.5 mV	CV
9	V 4 ENTER	:VOLT 4	4V ± 4.6 mV	DMM ± 6 mV	CV
10	V 7 ENTER	:VOLT 7	7V ± 5.8 mV	DMM ± 7.5 mV	CV

30V/10A/60W OUTPUT

	ACTION / KEY STROKES	EQUIVALENT REMOTE CMD	OUTPUT ACCURACY (DMM readout)	READBACK ACCURACY (display resolution 10 mV)	
7	I 2 ENTER	:CURR 2	xxxxxV	x.xx V	xx
8	V 1 ENTER	:VOLT 1	1V ± 10 mV	DMM ± 25 mV	CV
9	V 1 5 ENTER	:VOLT 15	15V ± 14 mV	DMM ± 32 mV	CV
10	V 2 9 ENTER	:VOLT 29	29V ± 19 mV	DMM ± 39 mV	CV

60V/2A/120W OUTPUT

	ACTION / KEY STROKES	EQUIVALENT REMOTE CMD	OUTPUT ACCURACY (DMM readout)	READBACK ACCURACY (display resolution 10 mV)	
7	I 1 ENTER	:CURR 1	xxxxxV	x.xx V	xx
8	V 2 ENTER	:VOLT 2	2V ± 23 mV	DMM ± 15 mV	CV
9	V 3 0 ENTER	:VOLT 30	30V ± 34 mV	DMM ± 29 mV	CV
10	V 5 8 ENTER	:VOLT 58	58V ± 45mV	DMM ± 43 mV	CV

60V/5A/60W OUTPUT

	ACTION / KEY STROKES	EQUIVALENT REMOTE CMD	OUTPUT ACCURACY (DMM readout)	READBACK ACCURACY (display resolution 10 mV)	
7	I 1 ENTER	:CURR 1	xxxxxV	x.xx V	xx
8	V 2 ENTER	:VOLT 12	2V ± 21 mV	DMM ± 50 mV	CV
9	V 3 0 ENTER	:VOLT 30	30V ± 29 mV	DMM ± 64 mV	CV
10	V 5 8 ENTER	:VOLT 58	758V ± 37 mV	DMM ± 79 mV	CV

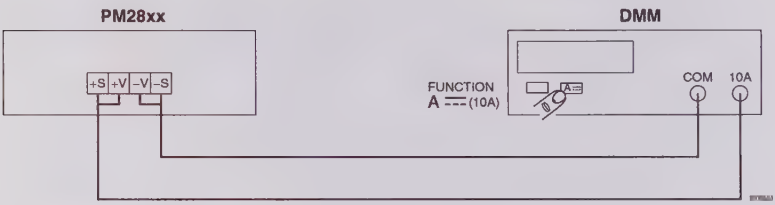
60V/10A/120W OUTPUT

	ACTION / KEY STROKES	EQUIVALENT REMOTE CMD	OUTPUT ACCURACY (DMM readout)	READBACK ACCURACY (display resolution 10 mV)	
7	I 2 ENTER	:CURR 2	xxxxxV	x.xx V	xx
8	V 2 ENTER	:VOLT 2	2V ± 321 mV	DMM ± 451 mV	CV
9	V 3 0 ENTER	:VOLT 30	30V ± 29 mV	DMM ± 68 mV	CV
10	V 5 8 ENTER	:VOLT 58	58V ± 37 mV	DMM ± 84 mV	CV

120V/1A/120W OUTPUT

	ACTION / KEY STROKES	EQUIVALENT REMOTE CMD	OUTPUT ACCURACY (DMM readout)	READBACK ACCURACY (display resolution 10 mV)	
7	I • 5 ENTER	:CURR 0.5	xxxxxV	x.xx V	xx
8	V 4 ENTER	:VOLT 4	4V ± 46 mV	DMM ± 431 mV	CV
9	V 6 0 ENTER	:VOLT 60	60V ± 69 mV	DMM ± 59 mV	CV
10	V 1 1 6 ENTER	:VOLT 116	116V ± 91 mV	DMM ± 87 mV	CV

OUTPUT CURRENT VERFICATION



Requirements: PM28xx must be in CC (Constant Current mode).

8V/15A/120W OUTPUT

	ACTION / KEY STROKES	EQUIVALENT REMOTE CMD	OUTPUT ACCURACY (DMM readout)	READBACK ACCURACY (display resolution 10 mV)	
11	V 4 ENTER	:VOLT 4	xxxxxA	x.xxx A	xx
12	I 1 • 5 ENTER	:CURR 1.5	1.5A ± 6 mA	DMM ± 8 mA	CC
13	I 7 • 5 ENTER	:CURR 7.5	7.5A ± 9 mA	DMM ± 11 mA	CC
14	I 1 0 ENTER	:CURR 10	10A ± 11 mA	DMM ± 11.5 mA	CC

30V/10A/60W OUTPUT

	ACTION / KEY STROKES	EQUIVALENT REMOTE CMD	OUTPUT ACCURACY (DMM readout)	READBACK ACCURACY (display resolution 10 mV)	
11	V 5 ENTER	:VOLT 45	x.xxxA	x.xxx A	xx
12	I 1 ENTER	:CURR 1	1A ± 50 mA	DMM ± 30 mA	CC
13	I 5 ENTER	:CURR 5	5A ± 50 mA	DMM ± 35 mA	CC
14	I 9 ENTER	:CURR 9	9A ± 50 mA	DMM ± 39 mA	CC

60V/2A/120W OUTPUT

	ACTION / KEY STROKES	EQUIVALENT REMOTE CMD	OUTPUT ACCURACY (DMM readout)	READBACK ACCURACY (display resolution 10 mV)	
11	V 1 0 ENTER	:VOLT 10	x.xxxA	x.xxx A	xx
12	I • 2 ENTER	:CURR 0.2	0.2A ± 0.8 mA	DMM ± 1 mA	CC
13	I 1 ENTER	:CURR 1	1A ± 1.1 mA	DMM ± 1.5 mA	CC
14	I 1 • 8 ENTER	:CURR 1.8	1.8A ± 1.4 mA	DMM ± 1.9 mA	CC

60V/5A/60W OUTPUT

	ACTION / KEY STROKES	EQUIVALENT REMOTE CMD	OUTPUT ACCURACY (DMM readout)	READBACK ACCURACY (display resolution 10 mV)	
11	V 1 0 ENTER	:VOLT 10	x.xxxA	x.xxx A	xx
12	I • 5 ENTER	:CURR 0.5	0.5A ± 25 mA	DMM ± 15 mA	CC
13	I 2 • 5 ENTER	:CURR 2.5	2.5A ± 25 mA	DMM ± 17 mA	CC
14	I 4 • 5 ENTER	:CURR 4.5	4.5A ± 25 mA	DMM ± 19 mA	CC

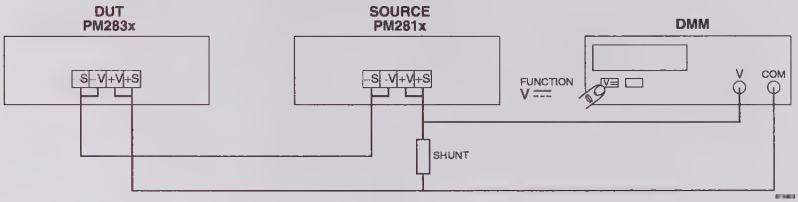
60V/10A/120W OUTPUT

	ACTION / KEY STROKES	EQUIVALENT REMOTE CMD	OUTPUT ACCURACY (DMM readout)	READBACK ACCURACY (display resolution 10 mV)	
11	V 1 0 ENTER	:VOLT 10	x.xxxA	x.xxx A	xx
12	I 1 ENTER	:CURR 1	1A ± 50 mA	DMM ± 31 mA	CC
13	I 5 ENTER	:CURR 5	5A ± 50 mA	DMM ± 39 mA	CC
14	I 9 ENTER	:CURR 9	9A ± 50 mA	DMM ± 48 mA	CC

120V/1A/120W OUTPUT

	ACTION / KEY STROKES	EQUIVALENT REMOTE CMD	OUTPUT ACCURACY (DMM readout)	READBACK ACCURACY (display resolution 10 mV)	
11	V 1 0 ENTER	:VOLT 10	x.xxxA	x.xxx A	xx
12	I • 1 ENTER	:CURR 0.1	0.1A ± 0.4 mA	DMM ± 0.5 mA	CC
13	I • 5 ENTER	:CURR 0.5	0.5A ± 0.5 mA	DMM ± 0.7 mA	CC
14	I • 9 ENTER	:CURR 0.9	0.9A ± 0.7 mA	DMM ± 0.9 mA	CC

OUTPUT CURRENT VERIFICATION (SINK CURRENT) (PM2831/32 only)



Required settings

SETTINGS	DUT PM283x	SOURCE PM281x
Voltage	$<V_{set}>$ 1)	$<V_{set}>$ + 4V
Current	$<I_{set}>$ 2)	$<I_{set}>$ + 0.5A
Mode	CC	CV

1) Same as for step 11.
2) Same as for steps 12 to 14.

ALL OUTPUT MODULES

15	Repeat steps 11 to 14 to verify the output and readback accuracies for sink currents.

OVERVOLTAGE PROTECTION VERIFICATION

Disconnect all connections to the output channel.

8V OUTPUT

	ACTION / KEYSTROKES	EQUIVALENT REMOTE COMMAND	PM28xx DISPLAY
16	I 2 ENTER	:CURR .2	n xx.xxV xx
17	OVP 7 ENTER	:VOLT:PROT 7	n xx.xxV xx
18	V 6 • 9 ENTER	:VOLT 6.9	n 6.90V CV
19	− V + Press key + side repeatedly, causing 2.5 mV steps, until OVERVOLTAGE is displayed.	:VOLT 6.90 :VOLT 6.90 :VOLT 6.90 :VOLT 6.91 .... etc.	n OVERVOLTAGE
20	V	:VOLT?	n VSET 7V ± 7 mV
21	V 6 • 9 ENTER	:VOLT 6.9	n OVERVOLTAGE
22	RESET	:OUTP:PROT:CLE	n 6.90V CV

30V OUTPUT

	ACTION / KEYSTROKES	EQUIVALENT REMOTE COMMAND	PM28xx DISPLAY
16	I 2 ENTER	:CURR 2	n x.xxV 0.00A xx
17	OVP 2 9 ENTER	:VOLT:PROT 29	n x.xxV 0.00A xx
18	V 6 8 ENTER	:VOLT 28	n 28.00V 0.00A CV
19	− V + Press key + side repeatedly, causing 7.5 mV steps, until OVERVOLTAGE is displayed.	:VOLT 28.0075 :VOLT 28.0150 .... etc.	n OVERVOLTAGE
20	V	:VOLT?	n VSET 29V ± 0.3V
21	V 2 8 ENTER	:VOLT 28	n OVERVOLTAGE
22	RESET	:OUTP:PROT:CLE	n 28.00V 0.00A CV

60V OUTPUT

	ACTION / KEYSTROKES	EQUIVALENT REMOTE COMMAND	PM28xx DISPLAY
16	I • 5 ENTER	:CURR .5	n x.xxxV 0.000A xx
17	OVP 5 9 ENTER	:VOLT:PROT 59	n x.xxxV 0.000A xx
18	V 5 8 ENTER	:VOLT 58	n 58.00V 0.000A CV
19	– V + Press key + side repeatedly, causing 15 mV steps, until OVERVOLTAGE is displayed.	:VOLT 58.015 :VOLT 58.030 .... etc.	n OVERVOLTAGE
20	V	:VOLT?	n VSET 59V ± 40 mV
21	V 5 8 ENTER	:VOLT 58	n OVERVOLTAGE
22	RESET	:OUTP:PROT:CLE	n 58.00V 0.000A CV

120V OUTPUT

	ACTION / KEYSTROKES	EQUIVALENT REMOTE COMMAND	PM28xx DISPLAY
16	I • 2 5 ENTER	:CURR .25	n x.xxxV 0.000A xx
17	OVP 1 1 9 ENTER	:VOLT:PROT 119	n x.xxxV 0.000A xx
18	V 1 1 8 ENTER	:VOLT 118	n 118.00V 0.000A CV
19	– V + Press key + side repeatedly, causing 30 mV steps, until OVERVOLTAGE is displayed.	:VOLT 118.03 :VOLT 118.06 .... etc.	n OVERVOLTAGE
20	V	:VOLT?	n VSET 119V ± 80 mV
21	V 1 1 8 ENTER	:VOLT 118	n OVERVOLTAGE
22	RESET	:OUTP:PROT:CLE	n 118.00V 0.000A CV

OVERCURRENT PROTECTION VERIFICATION

ALL OUTPUTS

	ACTION / KEYSTROKES	EQUIVALENT REMOTE COMMAND	PM28xx DISPLAY
23	OPR STBY	:INST:STAT OFF	n STANDBY

Repeat the complete PERFORMANCE VERIFICATION procedure for each output channel.

The following descriptions refer to the numbers on the left margins in the tables.

1. This is only necessary if you want to verify several output channels (not for PM2811 and PM2831).
2. Always set the output channel to 0V, 0A
3. Overvoltage Protection may not trip. Therefore, set its trip level to maximum (see module specifications in Appendix A).
4. Overcurrent Protection may not trip. Therefore, disable it to occur.
5. The selected output channel must be set ENABLED to get output from it (not for PM2811 and PM2831).
6. The power supply must be in OPERATE mode to get output from any channel.
7. This sets the output in its specified current control range.
   Values indicated in the table as xxxxx are not relevant.
8. Verify DMM readout and readback voltage. Also check that the CV indicator is on.
9. Same as 8.
10. Same as 8.
11. This sets the output in its specified voltage control range.
12. Verify the output current and the readback current. Also check that the CC indicator is on. The output current can be calculated by dividing the DMM readout (voltage) by the shunt resistance.
13. Same as 12.
14. Same as 12.
15. The PM283x can act as a source as well as a load. This step verifies the output and readback accuracies of the PM283x while acting as a load. To make it act as a load, you must apply an external voltage which is higher than the voltage setting of the PM283x. To get it in Constant Current mode, the current setting of the external source (PM281x) must be higher than the current setting of the PM283x.
16. This sets the output in its specified current control range.
17. This sets the Overvoltage Protection level to the channel's maximum output voltage minus 1V.

18. This sets the voltage at the output 1V below the Overvoltage Protection level.
19. Now increase the output voltage carefully, step by step, by pressing the plus-side of the [- V +] key. When a GPIB program is used, you may program an increasing value. The voltage steps should be equal to the programming resolution. When the voltage reaches the Overvoltage trip level, the protection circuit will trip and will switch off the output. At this moment, verify the voltage setting by pressing the [V] key (step 20) or reading the response from the VOLT? query.
20. Press [V] to verify the voltage setting that caused the Overvoltage Protection circuit to trip.
21. Bring the voltage setting back to the level of step 18.
22. Reset the Protection Circuit. The OVERVOLTAGE message should disappear from the display.
23. This tests the (hardware) mechanism that switches an output off. Overcurrent protection uses this mechanism. It is detected by the firmware when an output becomes in CC (Constant Current) mode while Overcurrent Protection is enabled. This test does not verify the firmware control of the mechanism.
    Check that the display shows 'STANDBY'.

APPENDIX C
CALIBRATION PROCEDURE

REQUIREMENTS

- RECOMMENDED EQUIPMENT — REQUIRED SPECIFICATIONS

  Digital Multimeter (DMM): — DC voltage accuracy 0.01%
  Fluke 8840 or PM2534

  Shunt: — Accuracy 0.01% *(See the Note).*
  Guildline Model 9230/15 (0.1Ω) for I≤5A
  Guildline Model 9230/100 (0.01Ω) for I>5A
  Note:To achieve the required accuracy, the shunt must be calibrated to use it as a transfer standard.

- Warmup time for both the DMM and the PM28xx:
  30 minutes to rated specifications.

- Calibration temperature 21°C to 25°C.

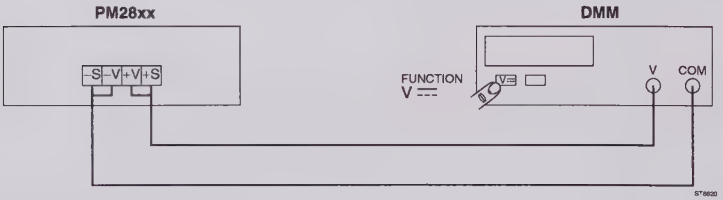


Figure C.1 Setup for voltage calibration

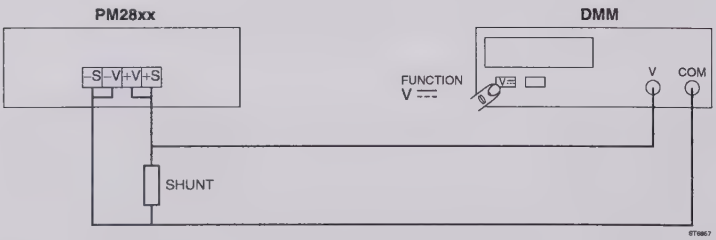


Figure C.2 Setup for source current calibration

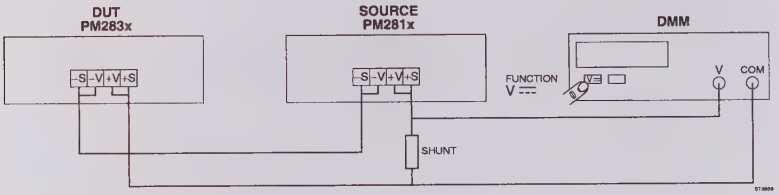


Figure C.3 Setup for sink current calibration

NOTES TO THE FOLLOWING CALIBRATION PROCEDURE:

- There are two ways to calibrate the power supply:
  - LOCAL CALIBRATION SEQUENCE:
    This is performed via the front panel keys.
  - REMOTE CALIBRATION SEQUENCE:
    This is performed by means of messages via the GPIB.

  Along with the key sequence (manual control), the equivalent remote sequence is also given. This helps you to write your own remote controlled calibration procedure. The key strokes for the manual calibration sequence are not directly related to the remote messages for the remote calibration sequence given in the same table. You cannot combine the local and the remote sequence in the same calibration session, i.e., you must select either the local sequence or the remote sequence. The PM28xx display data is only applicable to the local sequence.

- ACTION / KEY STROKES:

Example: [2] [8] [3] [1] [ENTER]	This means that you must press the indicated keys in the given order.
<DMM_readout> [ENTER]	This means that you must enter the DMM measurement value via the PM28xx numeric keypad (see Note).

Note:If a shunt is used for the current measurement, replace the value for <DMM-readout> with the calculated current value. You can calculate the current by dividing the DMM readout (voltage across the shunt) by the shunt resistance.

- REMOTE SEQUENCE:
  This sequence gives only the command string data. Refer to the user manuals of your GPIB controller for information about remote control of GPIB devices. Refer to the user manuals of the DMM for information about how to program the DMM functions and how to read out the DMM measurement results <DMM_readout> via the GPIB.

- PM28xx DISPLAY:
  This gives messages and status data shown on the PM28xx display during the local calibration sequence.
  n = Selected output channel number (only for multiple output models).
  CV = Constant Voltage annunciator; CC = Constant Voltage annunciator.
  If CV or CC is given in the following tables, check if the annunciator is displayed. If it is not displayed, check if the wiring to the PPS terminals and to the DDM inputs is correct, if the correct output channel is selected, and if the DMM is set to the correct measuring function and if the measuring leads are connected to the correct inputs.

SEQUENCE NUMBER	LOCAL CALIBRATION SEQUENCE		REMOTE CALIBRATION SEQUENCE	
	ACTION / KEY STROKE	PM28xx DISPLAY	REMOTE MESSAGE	NOTES *)
1	Turn power on while pressing [AUX]	1 CODE	*RST :INST:STAT ON :SYST:UNPR ON	
2	<code> [ENTER]	1 CALIBRATE ON	:SYST:UNPR:SEL <code> :SYST:ERR?	1 8
3	[SELECT]	n CALIBRATE ON	:INST:NSEL <n>	2
4	Make the setup shown in figure C.1 for voltage calibration.			
5	[ENTER]	n VCAL LOW	:OUTP:STAT ON :CAL:STAT OFF :CURR <curr_val>	3
6	[ENTER]	n VCAL CV	:VOLT MIN :SOUR:FUNC:MODE?	13 10
7	<DMM_readout> [ENTER]	n VCAL HIGH	:CAL:VAL <DMM_readout> :SYST:ERR?	4 9
8	[ENTER]	n VCAL CV	:VOLT MAX :SOUR:FUNC:MODE?	13 10
9	<DMM_readout> [ENTER]	n ICAL LOW	:CAL:VAL <DMM_readout> :SYST:ERR? :CURR 0 :VOLT 0	4 9
10	Make the setup shown in figure C.2 for source current calibration.			

*) See the notes at the back of this Calibration Procedure.

SEQUENCE NUMBER	LOCAL CALIBRATION SEQUENCE		REMOTE CALIBRATION SEQUENCE	
	ACTION / KEY STROKE	PM28xx DISPLAY	REMOTE MESSAGE	NOTES *)
11	ENTER	n ICAL CC	:VOLT <volt_val> :CURR MIN :SOUR:FUNC:MODE?	5 13 11
12	<DMM_readout> ENTER	n ICAL HIGH	:CAL:VAL <DMM-readout> :SYST:ERR?	4 9
13	ENTER	n ICAL CC	:CURR MAX :SOUR:FUNC:MODE?	13 11
14	<DMM_readout> ENTER	n OVCAL LOW	:CAL:VAL <DMM-readout> :SYST:ERR? :CURR 0 :VOLT 0	4 9
15	Make the setup shown in figure C.3 for sink current calibration (steps 15 to 19 only for linear power supplies).			12
16	ENTER	n ICAL CC	:VOLT <volt_val> :CURR MIN :SOUR:FUNC:MODE?	5 13 11
17	<DMM_readout> ENTER	n ICAL HIGH	:CAL:VAL <DMM-readout> :SYST:ERR?	4 9
18	ENTER	n ICAL CC	:CURR MAX :SOUR:FUNC:MODE?	13 11
19	<DMM_readout> ENTER	n OVCAL LOW	:CAL:VAL <DMM-readout> :SYST:ERR? :CURR 0 :VOLT 0	4 9

continued on next page

SEQUENCE NUMBER	LOCAL CALIBRATION SEQUENCE		REMOTE CALIBRATION SEQUENCE	
	ACTION / KEY STROKE	PM28xx DISPLAY	REMOTE MESSAGE	NOTES *)
20	Disconnect the power supply output for automatic overvoltage calibration and termination of the calibration procedure for channel n.			
		CV	:CURR <curr_val> :CAL:AUTO ONCE	3 6
21	ENTER	n MEASURE LOW n MEASURE HIGH n SAVING OFF	.... (delay the program for about five seconds)	
22	1	n SAVING n SAVING COMPLETED	:CAL:STAT ON	7
23	ENTER	n CALIBRATE ON		
24	If you want to calibrate the next channel, repeat the above procedure from sequence number 3 onwards.			
25	0	n STANDBY	:OUTP:STAT OFF :SYST:UNPR OFF	

*) See the notes at the back of this Calibration Procedure.

NOTES TO THE CALIBRATION PROCEDURE:

1. Replace <code> with the four digit password. At delivery from the factory, this password is set equal to the last four digits of the power supply typenumber.

2. LOCAL SEQUENCE: Press SELECT as many times as necessary to select the output channel.
   REMOTE SEQUENCE: Replace <n> with the output channel number.

3. Replace <curr_val> with a value that is equal to 10% of the maximum current of your power supply. You can query the maximum current with :CURR:LIM:HIGH?

4. Replace <DMM_readout> with the measurement value of the DMM.
   If a shunt is used for the current measurement, replace the value for <DMM-readout> with the calculated current value. You can calculate the current by dividing the DMM readout (voltage across the shunt) by the shunt resistance.
   To prevent drift of the DMM measurement result, caused by the current through the (DMM) shunt, do the measurement as quickly as possible (valid for current calibration).
   If you enter a value which is out of range, the PPS will report VCAL ERROR or ICAL ERROR. In this case repeat the measurement to enter the correct value.

5. Replace <volt_val> with a value that is equal to 10% of the maximum voltage of your power supply, but this value must be at least 3V. You can query the maximum voltage with :VOLT:LIM:HIGH?

6. This command will take about five seconds to complete. Insert a pause longer than five seconds after this command in your GPIB program.

7. If you want to save the new calibration data, press 1 (=ON); if you want to cancel the new calibration data, press 0 (=OFF).

8. The response to this query must be 0, "No error". If the error number is not zero, the Power Supply is not in calibration mode.

9. The response to this query must be 0, "No error". If the response is -200, "Execution error", the entered calibration value is out of range. In this case the measurement must be repeated to achieve a correct value.

10. The reponse to this query must be VOLT, indicating that the channel is in Constant Voltage (CV) mode.

11. The reponse to this query must be CURR, indicating that the channel is in Constant Current (CC) mode.

12. For calibration of the sink current it is necessary that the power supply to be calibrated (DUT) detects a negative output current (sink mode). This can be achieved by setting the external source voltage and current equal to the maximum voltage and current of the DUT.

13. The parameters MIN and MAX don't have their regular value during the calibration procedure.

APPENDIX D ERROR MESSAGES

D.1 Instrument error messages

D.1.1 Functional error messages

The following error messages can be displayed during operation:

n O V E R V O L T A G E	in the case of an overvoltage situation for output channel n
n O V E R C U R R E N T	in the case of an enabled overcurrent situation for output channel n
n F A I L	in the case of an overtemperature or an open sense for output channel n
n F A I L O U T P U T N	in the case of an overtemperature or an open sense for a coupled output channel N
n P R O T E C T I O N	in the case of a coupled output channel protection for output channel n
n F A U L T O U T P U T N	in the case of a fault for a coupled output channel N
n ▼ ▼ ▼ ▼ ▼	the displayed annunciator points at the fault or status text on the front panel

Note: The channel number n is not displayed for single channel models.

D.1.2 Hardware error messages

The following text + error code can be displayed:

ERROR n:ddd

n = indication of the error source
ddd = summation of the decimal equivalents of the individual error bits

The following error codes are possible:

0) Main CPU error: (n = 0)

bit:	decimal:	error description:
7	128	display controller failure
6	64	bank switch failure
5	32	not used
4	16	D^2B failure
3	8	IEEE controller failure
2	4	processor timer failure
1	2	RAM failure
0	1	ROM failure

1) CPU error of output channel 1: (n = 1)

bit:	decimal:	error description:
7	128	not used
6	64	ROM checksum error
5	32	CONFIG checksum error
4	16	CAL(ibration) checksum error
3	8	DEFSET checksum error
2	4	processor timer failure
1	2	not used
0	1	output channel not responding

2) CPU error of output channel 2: (n = 2)

conform 1)

3) CPU error of output channel 3: (n = 3)

conform 1)

D.2 SCPI command/query error messages

Error class	Range of Error numbers	Standard Event Register
No Errors	0	
Command Error	-100 to -199	bit 5 CME
Execution Error	-200 to -299	bit 4 EXE
Device-Specific Error	-300 to -399	bit 3 DDE
Query Error	-400 to -499	bit 2 QYE

Note: The error lists specify standard SCPI (1990.0) error numbers and descriptions. For completeness all, defined errors have been listed.

D.2.1 Command errors

Error number:	Error description:
0	No error
-100	Command error
-101	Invalid character
-102	Syntax error
-103	Invalid separator
-104	Data type error
-105	GET not allowed
-108	Parameter not allowed
-109	Missing parameter
-110	Command header error
-111	Header separator error
-112	Program mnemonic too long
-113	Undefined header
-114	Header suffix out of range
-120	Numeric data error
-121	Invalid character in number
-123	Exponent too large
-124	Too many digits
-128	Numeric data not allowed
-130	Suffix error
-131	Invalid suffix
-134	Suffix too long
-138	Suffix not allowed
-140	Character data error
-141	Invalid character data
-144	Character data too long
-148	Character data not allowed

-150	String data error
-151	Invalid string data
-158	String data not allowed
-160	Block data error
-161	Invalid block data
-168	Block data not allowed
-170	Expression error
-171	Invalid expression
-178	Expression data not allowed
-180	Macro error
-181	Invalid outside macro definition
-183	Invalid inside macro definition
-184	Macro parameter error

D.2.2 Execution errors

Error number:	Error description:
-200	Execution error
-201	Invalid while in local
-202	Settings lost due to rtl (return to local)
-210	Trigger error
-211	Trigger ignored
-212	Arm ignored
-213	Init ignored
-214	Trigger deadlock
-215	Arm deadlock
-220	Parameter error
-221	Settings conflict
-222	Data out of range
-223	Too much data
-224	Illegal parameter value
-230	Data corrupt or stale
-231	Data questionable
-240	Hardware error
-241	Hardware missing
-250	Mass storage error
-251	Missing mass storage
-252	Missing media
-253	Corrupt media
-254	Media full
-255	Directory full
-256	File name not found
-257	File name error

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-281	Cannot create program
-282	Illegal program name
-283	Illegal variable name
-284	Program currently running
-285	Program syntax error
-286	Program runtime error

D.2.3 Device-specific errors

Error number:	Error description:
-300	Device-specific error
-310	System error
-311	Memory error
-312	PUD memory lost (Protected User Data)
-313	Calibration memory lost
-314	Save/recall memory lost
-315	Configuration memory lost
-330	Self-test failed
-350	Queue overflow

D.2.4 Query errors

Error number:	Error description:
-400	Query error
-410	Query INTERRUPTED
-420	Query UNTERMINATED
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